U. S. Steel Minntac

Twin Lakes Wild Rice Restoration Opportunities Plan

2015 Annual Report

December 31, 2015

Prepared For

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EXECUTIVE SUMMARY

The second full year of work related to the Twin Lakes Wild Rice Restoration Opportunities Plan (Plan) was completed during 2015. The Plan was developed and undertaken to satisfy Special Condition 10 of the United States Army Corps of Engineers (Corps) Wetland Permit 2011-00823-JCB.

Plan activities were initiated prior to freeze-up in 2013. The first full year of Plan activities to begin the process of assessing the potential for restoring wild rice in the Twin Lakes was completed in 2014. A majority of these activities were continued during 2015.

The primary Plan objectives during 2015 were to continue regular water quality and quantity characterization monitoring, collect lakebed sediment and pore water samples for characterization of a number of factors, improve on an intensive beaver control and beaver dam removal program started in 2014 to regulate the lake water levels, and continue characterization of the aquatic vegetation within the lakes.

U. S. Steel received Corps comments and critiques on the Plan 2014 Annual Report on October 15, 2015. The Corps comments and U. S. Steel responses are contained in Section 2.0 of this report. Due to the timing of the comments, any recommended procedural changes related to monitoring will be considered for the 2016 monitoring season.

Lake levels were once again monitored on a continuous basis during 2015 using a pressure transducer installed alongside the steel bridge separating Sandy Lake from Little Sandy Lake. Equipment vandalism and short periods of equipment malfunction resulted in several small gaps in the continuous lake level record for 2015. However, sufficient data is available to document the overall trend in water depths. Water depth measurements collected during the aquatic vegetation survey (August 18, 2015) allowed for the development of a lake contour map, which can be used in conjunction with the pressure transducer data to evaluate relative lake depths for any given day.

The intensive beaver trapping and dam removal program was successful, as evidenced by the overall reduction in lake levels. The trapping and dam removal efforts will continue in 2016 to ensure lake depths are held at levels most conducive to wild rice growth.

A revised method of evaluating sediment pore water quality was used during 2015 with the deployment of peepers. The peeper sample results indicated a potential seasonal sulfide generation component, which will be explored further in 2016.

Small-scale wild rice re-seeding efforts were completed near the end of the monitoring season in six separate areas, three in each of the two lakes. Each of the six areas was delineated by GPS and will be monitored throughout 2016 for wild rice growth.

1.0 Introduction

On December 10, 2012, the United States Army Corps of Engineers (Corps) issued Wetland Permit 2011-00823-JCB for wetland impacts resulting from the United States Steel (U. S. Steel) Minntac Western Progression Project. Special Condition 9 of Wetland Permit 2011-00823-JCB required U. S. Steel to submit a Twin Lakes Wild Rice Restoration Opportunities Plan (Plan) within 120 days of permit issuance. U. S. Steel submitted the Plan in final form (Revision 1) to the Corps on August 6, 2013. Special Condition 10 of the permit required implementation of the Plan no later than October 31, 2013. Activities related to the Plan were initiated on October 9, 2013. On November 22, 2013, the Corps approved Revision 1 of the Plan. Plan activities completed during 2013 and 2014 are provided in annual reports submitted to the Corps for each of those two years.

During 2015, a number of activities were completed in support of the Plan and / or in preparation for initiation, continuation, and / or completion of components of the Plan during subsequent monitoring seasons. The following provides the details of Plan activities undertaken during 2015, in partial fulfillment of Special Condition 10 contained in Corps Wetland Permit 2011-00823-JCB, and represents the culmination of two full years of work related to the required five-year work plan. It should be noted that, at this time, it is premature to draw any definitive conclusions with respect to any specific wild rice restoration opportunities for the Twin Lakes. However, discussion of preliminary results will be included in individual sections as appropriate.

2.0 Summary and Consideration of U.S. Army Corps of Engineers Comments on 2014 Annual Report

The Twin Lakes Wild Rice Restoration Opportunities Plan annual report for 2014 was submitted to the Corps in hardcopy format via Certified U.S. Mail on December 31, 2014, and in electronic format on January 7, 2015. U. S. Steel received Corps comments/concerns related to the 2014 Annual Report on October 15, 2015. A summary of those comments are presented here, along with responses from U. S. Steel. Because of the timing of receipt of the Corps comments, those concerns that require some type of change in monitoring, sampling, etc., will be incorporated into 2016 Plan activities where appropriate.

The format of the Corps comments and U. S. Steel responses are as follows:

2014 Annual Report Section

Comment #) Page # from Annual Report - passage in question (if any) *Corps comment*

U. S. Steel response

2.1 Twin Lakes Water Depth and Temperature Monitoring

Comment 1) Page 5 - *Water depth measurements at one location are not very helpful without the bathymetry of both lakes. What does the water depth at this location mean for water depths throughout the lakes? Please provide a map of lake depths including the measurement location.*

Water depth measurements were collected during the aquatic vegetation survey on August 18 at each of the sampling locations. In addition, the depth of the water at the middle of each lake was measured on May 22 and again on June 12 in conjunction with Secchi disk readings. These depth measurements provide the data needed to create a correlation with readings routinely collected at the steel bridge, i.e., continuous pressure transducer data and manual readings from the staff gauge affixed to the bridge abutment. A bathymetric map was developed estimating bottom contours of the Twin Lakes based on manual water depth measurements obtained during the aquatic plant survey (see **Figure 6**). The water level recorded from the steel bridge staff gauge was recorded as 2.4 feet that day.

2.2 Twin Lakes Sediment Cores, Pore water, and Bioassay

Comment 2) Page 6 - Regardless of sediment core length, some sediment cores provided fewer pore water 'depth' fraction results compared to other sediment cores due to insufficient volumes of recoverable sediment pore water. *Why might this be? Is the sediment too dense? Not enough pore space?*

Lack of sediment pore space is one possibility. However, sediment pore space depends on the solid phase sediment material present (i.e., loosely-associated organic debris; packed clay; sandy substrate). Extracting pore water from sediment cores for analyses has been replaced by using peepers as described in Section 3.3. Using peepers to characterize sediment pore water is most likely a more accurate pore water sampling method due to the decreased likelihood of exposing pore water to ambient atmosphere.

Comment 3) Page 8 - Chart 2 shows the results of the 2014 bioassay evaluations using sediment sampled in 2013. From a statistical standpoint, wild rice biomass in Sandy Lake sediment exposures with ambient air bubbled into the water column were significantly lower than both ambient air- and nitrogen- bubbled Whitefish Lake sediment exposures. *Why? This issue should be explored further. Is there an issue with sulfide oxidation?*

The method used for the initial Twin Lakes sediment bioassay included collection of a bulk sediment sample using an Ekman dredge, which allowed sediment contact with ambient atmosphere during field sampling, storage, and bioassay set-up. Currently, the bioassay method is being revised in an effort to more accurately maintain sediment and pore water characteristics from field-to-lab. This includes obtaining multiple sediment cores from each lake, freezing the cores, and removing the specific sediment depth (i.e., approximately top 10 cm) from the frozen core to be used in the bioassay. Sample collection was completed on June 29, 2015. This, and other method refinements, will allow for more representative and accurate bioassay data.

2.5 Twin Lakes Inflow / Outflow Water Characterization

Comment 4) Page 9 - Please note that after the water quality sampling event in June, the data were reviewed and those constituents that were reported below the detection limit were removed from future analysis. *State the number of samples below detection levels before the constituent was removed from analysis. Obviously constituent levels change due to flow rates, season, etc, so they should not be eliminated after only a few negative results.*

Comment noted. As detailed in the approved Twin Lakes Wild Rice Restoration Opportunities Plan, Section 5.3, analytes which were below detection in initial water samples were removed from subsequent analyte lists. However, during the 2016 field season, selected analytes that are at or near below detection will be 'spot checked' as described in Section 4.4.

2.6 Twin Lakes Inflow / Outflow Measurements

Comment 5) Page 11 - Flow measurements concurrent with multiple Twin Lakes inflow and outflow water sampling events were routinely obtained at the Inflow 1 sampling location, the outflow "Culvert" location, and the Station 701 monitoring location, i.e., the point at which U.S. Highway 53 crosses the Sand River. *Indicate on a map the location of Station 701 monitoring location.*

Comment noted. **Figure** 7 (Sand River Beaver Activity Survey Map) provides the location of the Station 701 monitoring location, i.e., upstream (west) side of box culvert under County Road 306, immediately upstream of U.S. Hwy 53.

Comment 6) Page 11 - As can be seen in the flow summary table presented in Appendix E, the measurable sources of inflow that contribute to discharge of the Sand River at the outlet of Sandy Lake did not match concurrent discharges measured at Station 701. In general, there is considerably more discharge downstream in the Sand River than can be accounted for from the three main inflow sources. *Given this, will data from Station 701 be used in any analysis? It seems unrepresentative of the system in question so the Sandy River Outflows 1 and 2 should be used, not Station 701.*

Comment noted. Station 701 was included in the monitoring plan because of the historical record of flow and water quality data available. Also, since there are no man-made stream crossings over the Sand River between Sandy Lake and County Road 306, safe access to an open-water stream transect was a prime consideration. Due to the timing of the comment no additional outlet flow monitoring was possible for 2015. However, early in the 2016 field monitoring season the Sand River immediately downstream of the Sandy Lake outlet will be resurveyed to evaluate locations that may be used to establish safe, routine flow monitoring.

2.7 Twin Lakes Aquatic Plant Survey

Comment 7) Page 12 - This may be due to the high observed water levels and resulting decreased light penetration through the tea-colored water in both lakes. *Light availability to seedlings is an important factor in aquatic vegetation success. I don't see any measurements of light penetration collected. Add a measurement of turbidity or a Secchi disk or transparency tube reading.*

Comment noted. Due to the timing of the comment no additional transparency monitoring was possible for 2015. However, Secchi disk readings were collected at the lake middle monitoring locations for both lakes on May 22 and June 12. Based on the results of the limited Secchi disk monitoring that was conducted in 2015, it appears that the statement regarding tea-colored water and decreased light penetration from the 2014 Annual Report is not valid.

2.8 Twin Lakes and Sand River Beaver trapping Program

Comment 8) Page 12 - The success of the beaver trapping and dam removal efforts can be seen by inspection of the trend in Twin Lakes water levels during 2014 (see the graph below and in Appendix A) and the Inflow / Outflow discharge measurements (Appendix E). *The impacts of beaver removal v. seasonal water level changes are not obvious. Develop the relationship further and note in the depth graph when beaver removal occurred.*

Comment noted. A greater effort has been made to include significant events, e.g., precipitation, beaver control activities, dam removal, etc., on the 2015 water level graph that might help to illustrate influences on water depth in the lakes.

Comment 9) Page 13 - Water Level and Temperature Graph *Include local rainfall events in this graph. Also, note units--depth in feet? Temp in C.*

Comment noted.

Twin Lakes Inflow / Outflow Sampling Event 5/28/2014

Comment 10) Page 30 - *Some of the sulfate levels in these samples are higher than the current MN standard of 10 mg / L for wild rice waters. A new proposed standard is a calculation that includes organic carbon and iron measurements. I recommend the authors use the proposed calculation to determine if and where sulfate standards exceed the proposed limit. Further study of sulfate levels at these sites will be useful in identifying factors limiting the growth of wild rice.*

Comment noted. The current MN standard for sulfate in waters used for the production of wild rice is 10 mg/L. However, neither Sandy Lake nor Little Sandy Lake has been officially designated, or listed in rule, as waters used for the production of wild rice. Therefore, the standard does not apply. Although MPCA has proposed the use of a structural equation model that could potentially be used to predict a protective sulfate concentration in the water column of any given water body that may support the production of wild rice, the process is currently going through public comment. As such, the proposed site specific equation may undergo additional changes before a new standard is promulgated. In addition, MPCA has not developed any accompanying guidance related to data requirements needed to calculate a protective water column sulfate concentration for a given site. For example, are multiple samples averaged, or a statistical analysis completed as input to the equation? Therefore, predicting a "protective" sulfate concentration based on the current equation is premature.

Comment 11) Page 30 - *Many of the alkalinity measurements are over the average wild rice waters average of 40mg / L (cited in Appx I, page 6). Is this a problem for wild rice production in these lakes?*

The citation states "Moyle suggested that WR was primarily found in waters with a total alkalinity less than 40 mg l^{-1}, pH between 6.8 – 7.0, and a sulfate concentration of less than 10 mg l^{-1}." Current research suggests that Moyle's observations do not necessarily coincide with protective concentrations of any particular constituent for the growth and propagation of wild rice. Given the current state of wild rice research, no conclusions regarding alkalinity can be drawn at this time. Assuming that the form of the total alkalinity measured during 2014 was entirely bicarbonate, the alkalinity in all Twin Lakes sampling locations during 2014 and reported in the 2014 Annual Report are all either at or well below the MN Class 4A standard of 5 meq/L (302 mg/L bicarb; 250 mg/L total as $CaCO_3$).

Twin Lakes Inflow / Outflow Sampling Event 6/23/2014

Comment 12) Page 31 - *Is this (Trib from Culvert) the same as the sample location called "Culvert Outflow 1" on the map?*

Yes, "Culvert Outflow 1" shown on **Figure 3** in the 2014 Annual Report is the same sampling location as that referred to as "Trib from Culvert" shown in the June – October monthly sampling events.

Comment 13) Page 31 - *This sample event has data for the two lakes while the other events do not. It is helpful to have the lake data to compare. Please include lake data in future sample events.*

Comment noted. Samples from the middle of each of the two Twin Lakes were included in the monthly sampling routine for 2015.

Trib From Culvert

Comment 14) Page 41 - *What is the significance of the red?*

Values that were considered to be unusually high compared to the remainder of the data set were shown in bold red. However, the manganese value from the 6/23/14 Trib from Culvert sampling event should have been shown in bold black font (above the detection limit). No such convention will be used in the 2015 report or any future reports.

2014 Inflows & Outflows of Twin Lakes

Comment 15) Page 43 - *I don't understand this table. Inflow 2 and Inflow 3 seem to be missing, as well as Sand River Outflow 2. Please provide a better water budget table showing all inputs to the lakes and all outflows from the lakes for a series of dates.*

The original plan called for regular flow sampling at the Inflow 2 and Inflow 3 locations. However, once routine sampling was initiated it became obvious that it would be impossible to obtain representative flow rates at these two locations. The reason for this is two-fold: 1) Inspection of aerial photos suggests that there are defined inflow channels at each of the two locations. However, the "channels" are extremely shallow and choked with vegetation during a majority of the open water season, preventing effective flow measurement. Additionally, as lake levels were brought down through beaver control and dam removal efforts, there was a corresponding drop in water levels in the "channels," preventing canoe access. Access by foot is not an option. 2) Although aerial photos would lead one to believe that flow is generally restricted to the channels, in reality flow into Little Sandy Lake in the vicinity of Inflow 2 and Inflow 3 is very diffuse, coming in across the entire width of the wetland complex. Additionally, based on visual observations during monthly sampling events, it is believed that the magnitude of flow from Inflow 2 and Inflow 3 is minimal in comparison to that entering Little Sandy Lake from the Sand River at Inflow 1.

See Comment 6 above for a discussion of plans for establishing a representative flow monitoring station for Sand River Outflow 2 (now referred to as 'Twin Lakes Outflow') during 2016.

Sandy Lake and Little Sandy Lake Aquatic Plant Surveys Completed on 9-11-2014 and 9-15-2014

Comment 16) Page 47 - A map is attached with the vegetation sampling transects and sampling locations. *No map attached. Please provide.*

Comment noted – this was an oversight. A map of the 2014 aquatic plant survey transects will be included in the 2015 Annual Report along with the corollary for 2015.

3.0 Work Completed in 2015

3.1 Twin Lakes Rainfall, Water Depth, and Temperature Monitoring

To evaluate the effect of natural hydrologic inputs to and outputs from the Twin Lakes system, and implementation of various aspects of the Plan, the depth of water at the northwest side of the steel bridge which separates the two lakes has been monitored. To facilitate continuous water level measurements, an OTT / Hach pressure transducer (PT) was purchased and deployed for approximately 1.5 months in 2013 and six full months in 2014. On April 24, 2015, immediately following ice-out, the PT was re-deployed at the same location. The PT was found to have been vandalized on June 30 after downloading the data on July 10. The PT was repaired on July 17, and placed back into service. On July 20, the PT was re-checked and data were down-loaded with no problems. On August 5, the PT was found inoperable and unable to download data. A different PT was installed on August 7, which continued to perform, without incident, until it was removed on November 9, 2015 prior to freeze-up. Daily precipitation totals collected at a Soil and Water Conservation Service monitoring site approximately 4 miles east were compiled for comparative purposes. The results of the 2015 monitoring for rainfall, water depth and temperature can be found in Appendix A. A partial explanation for the observed variation in water levels is detailed in Section 3.8.

3.2 Twin Lakes Sediment Bioassay

During October 2013, multiple sediment sampling events were completed to collect sediment samples from each lake for use in a wild rice bioassay.

During 2013 and 2014, initial wild rice bioassays were completed using bulk sediment sampled from Sandy Lake.

Initial results of the wild rice sediment bioassay support the conclusion that wild rice seed (obtained from Whitefish Lake, Ontario, CA) successfully germinated and developed into viable seedlings during exposure to sediment sampled from Sandy Lake.

A one-way analysis of variance was used to determine statistical differences between average biomass measurements of each treatment group (SigmaStat 13.0; Systat Software, Inc.). Statistical differences were further discerned using an appropriate multiple-comparison test.

During the 2013 bioassay evaluations, from a statistical standpoint biomass of wild rice seedlings germinated during exposure to Sandy Lake sediment was significantly higher than biomass of wild rice seedlings germinated during exposure to Whitefish Lake sediment. No other statistical differences were observed between 2013 treatment groups using this statistical method. Also, wild rice seedling biomass in Sandy Lake sediment exposures with single bubble aeration of the water column were significantly lower than Whitefish Lake exposures. However, Sandy Lake sediment exposures with nitrogen bubbled into the water column were not significantly different than Whitefish Lake sediment exposures. See U. S. Steel response to Corps Comment #3 in Section 2.2 for a discussion of these results.

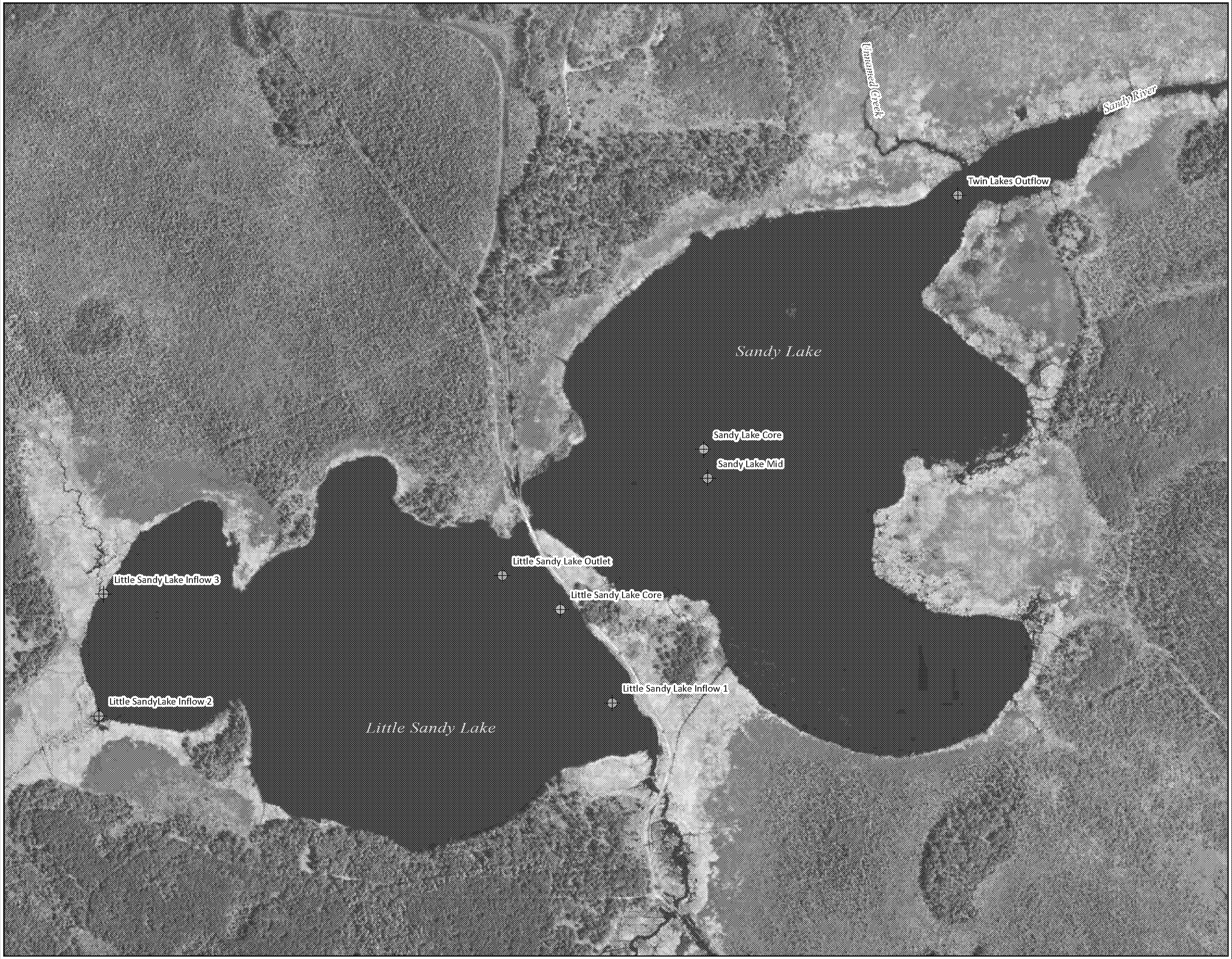
3.3 Twin Lakes Sediment Core and Peeper Pore Water

During 2013 and 2014, a number of sediment and pore water samples were obtained using two inch-diameter sediment coring devices of varying lengths over the course of several sampling events. Although this is the preferred method for collecting sediment samples and obtaining measurements of physical and chemical sediment characteristics, this method is lacking with respect to sediment pore water collection and characterization. This was evidenced by the inability to retrieve sufficient volumes of pore water from some of the sediment cores sampled during 2013 and 2014.

A more effective and defensible method of sediment pore water sampling and characterization is through the use of peeper style samplers (see **Image 1** below). Six peepers were deployed during the 2015 field season; four in Little Sandy Lake and two in Sandy Lake (see **Figure 1**). Deployment locations were chosen due to measured concentrations of sulfide above the reporting limit from sediment core samples obtained during 2013 and 2014; and for their representativeness of the Twin Lakes inflows, outflow, and middle areas. Peepers were deployed for three, (approx.) 30-day durations between July – August, August – September, and September – October; and were re-deployed immediately following removal of the sample tubes, and replacement of new sample tubes, after each respective 30-day deployment duration. The first set of 50 mL centrifuge tubes containing peeper samples were sealed using parafilm, and stored and transported on ice to Dr. Peter Lee for analysis at Lakehead University Environmental Laboratory (LUEL). The second and third set of peeper samples were treated as follows: two of the four, 50 mL volumes of sample were poured into a sodium hydroxide / zinc acetate preserved bottle for sulfide measurement (100 mL total). This was done in an effort to minimize exposure of the pore water samples to ambient atmosphere prior to preservation. The remaining two, 50 mL samples were sealed. All samples were stored and transported on ice to Dr. Lee for analysis at LUEL.

Image 1. Peeper sediment pore water sampling device.

Peepers (as pictured above) were deployed with sealed 50 mL centrifuge tubes within the top 10 cm of sediment. Each 50 mL centrifuge tube was completely filled (no headspace) with deionized water obtained from Pace Analytical Laboratories (Pace; Virginia, MN); this is the type of purified water Pace uses for formulating their analytical standards, and periodic 'blank' samples. Each tube contained a 0.45 µM pore size filter in the cap to allow for deionized water / pore water equilibration via diffusion. Using peepers to collect pore water samples for characterization can better minimize, if not eliminate, the potential for the collected pore water to be exposed to air / oxygen.



N

0 250 500 1,000
Feet
1 Inch = 500 Feet

Legend

Peeper Deployment

Sediment Core

Notes:

-Samples Collected June 29, 2015

Figure 1
2015 Sediment Sample and Peeper Deployment Locations

Twin Lakes
US Steel Corporation -
Minnesota Ore Operations
Mt. Iron, Minnesota (St. Louis County)

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Drawn By : Evan Johnson	1
NTS Project #: 10170E	

During July – October 2015, measured concentrations of pore water sulfide and extractable iron concentrations were inversely correlated (Appendix B); pore water sulfide concentrations tended to increase as pore water extractable iron concentrations tended to decrease. Also, in general, it appears that pore water sulfide concentrations increased through the 2015 field monitoring season. This suggests that a seasonal influence may exist. This phenomenon will be investigated further during the 2016 field season (see Section 4.2).

During October 2013, multiple sediment sampling events were completed in an effort to obtain sufficient number of samples to characterize Little Sandy and Sandy Lake sediment conditions. Dr. Peter Lee has provided an evaluation of sediment pore water characteristics including a comparison between Little Sandy Lake and Sandy Lake, previous MPCA pore water data, and a Canadian wild rice producing lake (Whitefish Lake) (see Appendix B).

3.4 Twin Lakes Sediment 100 Year Pollen Count

Sediment core samples were obtained for completion of a '100 Year Pollen Count' on May 30, 2014 (**Figure 2**). This particular component of the Plan is one of the more complex and energy intensive analyses. During 2015, sediment from the two cores selected for the 100 Year Pollen Count (LSL2 and SL1) was prepped for scanning electron microscopy (SEM) observation. This included cleaning, drying, and fixing sediment material from each core to respective SEM stubs. Following several hours of sample imaging, pollen grains were observed in Sandy Lake sediment (**Appendix C**). Although these pollen grains do appear to be wild rice pollen grains, currently a verification process is being completed. Pollen from known wild rice plants is being imaged in an effort to confirm that the pollen grains imaged from Sandy Lake sediment are wild rice pollen grains.

3.5 Twin Lakes Inflow / Outflow Water Characterization

Beginning May 28, 2015, monthly water sampling of inflow and outflow from the Twin Lake system was resumed for the 2015 monitoring season. Water characterization sampling sources included the inflows to Little Sandy Lake, a tributary to Sandy Lake from the north into its northeast arm (Culvert Inflow), and the Twin Lakes system outflow (Twin Lakes Outflow, previously referred to as Outflow 2 Sand River) (**Figure 3**). It should be noted that the inflow samples referred to above were collected either from active, measurable inflow (Inflow 1) or from areas at the periphery of the lake in close proximity to what appears to be inflow channels from aerial photos (Inflow 2 and Inflow 3). The Inflow 2 and Inflow 3 "channels" were not accessible by canoe for the majority of 2015 due to reduced water levels and vegetation, and therefore samples were collected at the mouth of the inflow channels. Water was also sampled from the center of each lake (Little Sandy Lake Mid and Sandy Lake Mid) during each monthly sampling event. A description of each of the sampling sources, with the exception of the lake mid-point samples, is provided here:

<u>Inflow 1</u> – corresponds to the discharge of the Sand River into the southeast quadrant of Little Sandy Lake. Water quality samples are collected from the inflow channel approximately 50 feet downstream of a wooden suspension snowmobile bridge crossing the Sand River at the inlet.

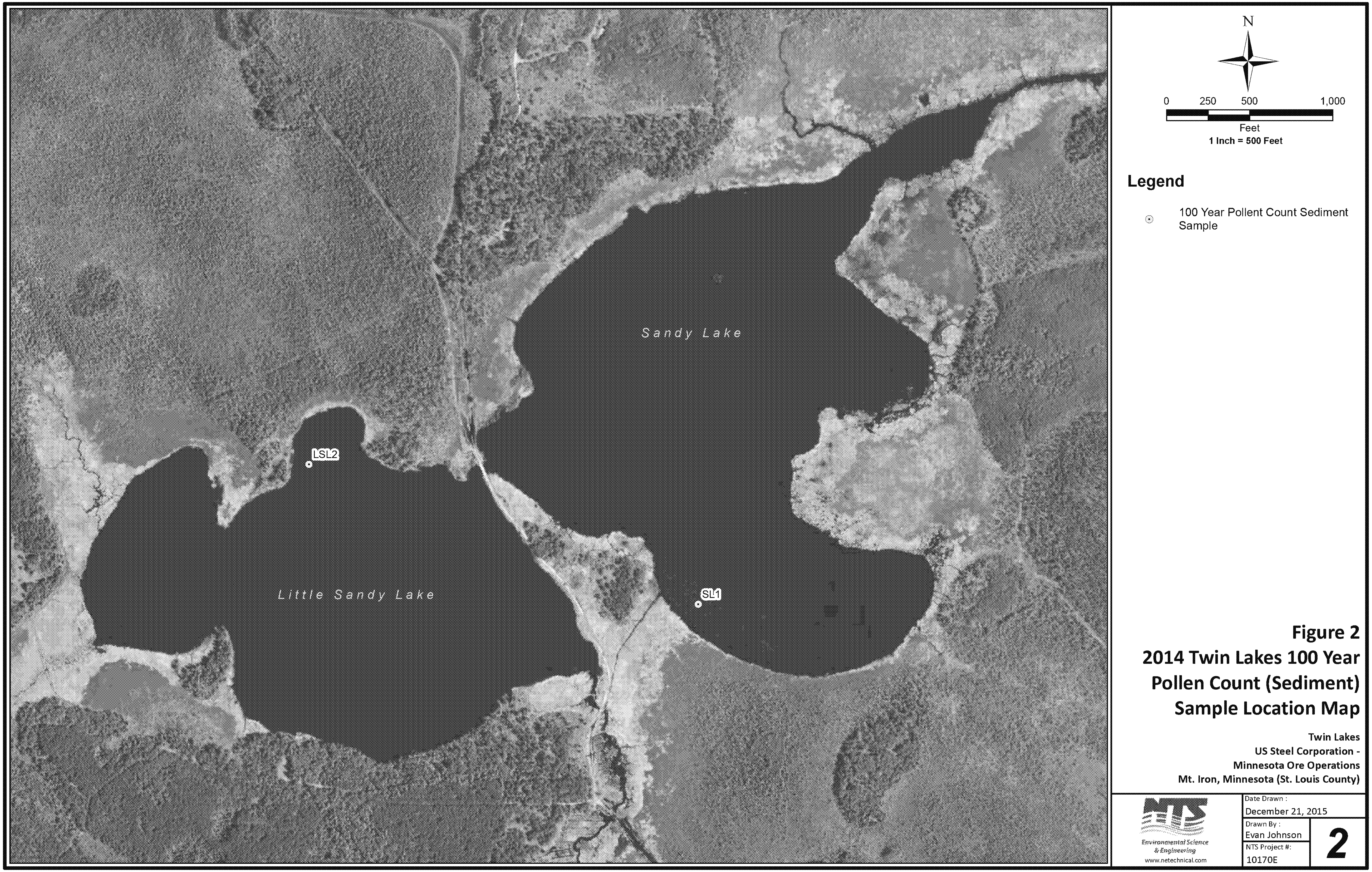

Figure 2
2014 Twin Lakes 100 Year Pollen Count (Sediment) Sample Location Map

Twin Lakes
US Steel Corporation -
Minnesota Ore Operations
Mt. Iron, Minnesota (St. Louis County)

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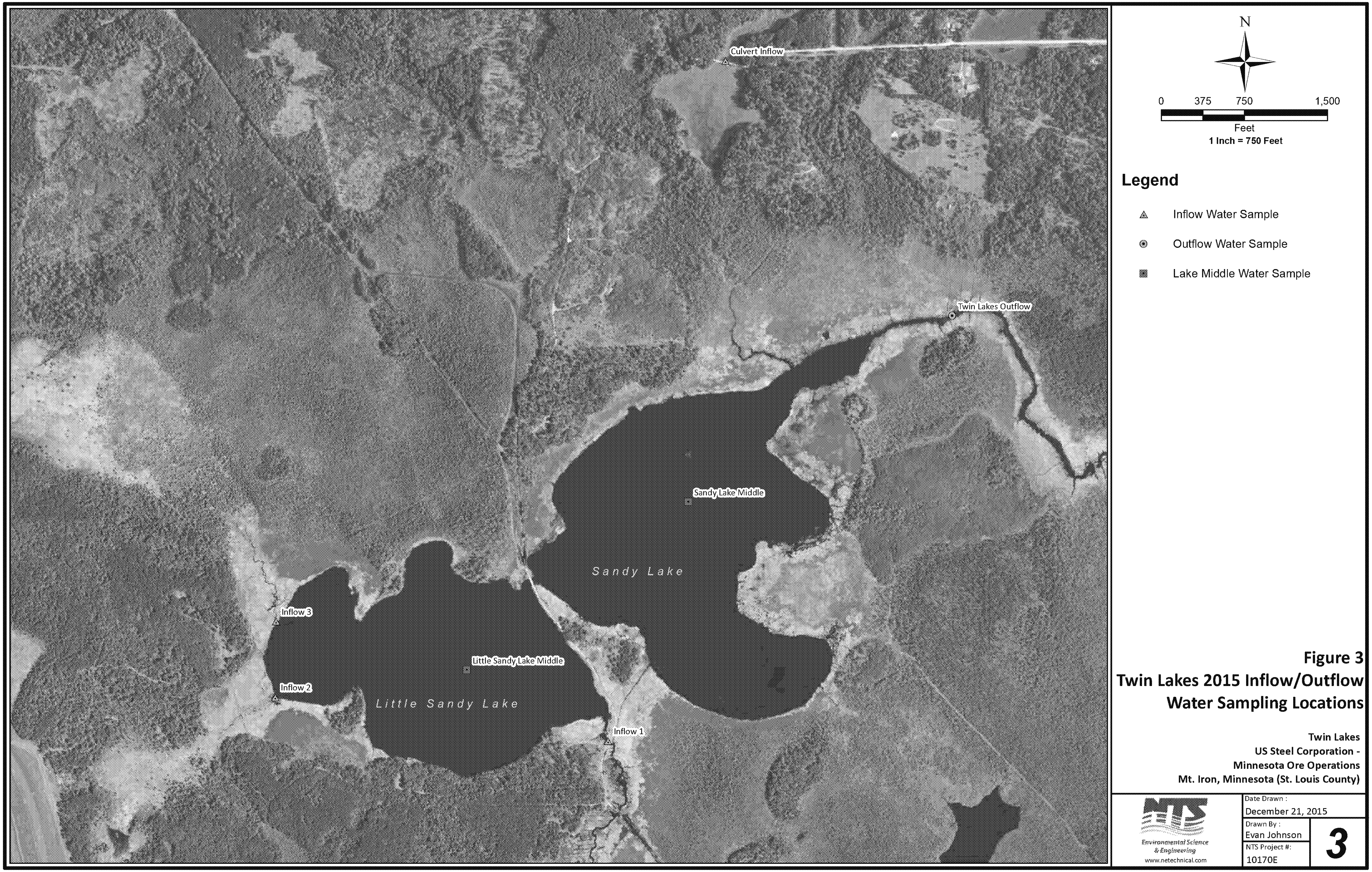

Figure 3
Twin Lakes 2015 Inflow/Outflow Water Sampling Locations

Twin Lakes
US Steel Corporation - Minnesota Ore Operations
Mt. Iron, Minnesota (St. Louis County)

Date Drawn : December 21, 2015
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Inflow 2 – represents flow entering Little Sandy Lake from a wetland complex to the west southwest that originates near the northeast corner of the Minntac tailings basin perimeter dike. The Inflow 2 sampling location is situated on the west side of Little Sandy Lake at the mouth of an east / west trending wetland flow channel.

Inflow 3 – represents discharge to the system from general wetlands present north of Little Sandy Lake. The Inflow 3 sampling location is situated on the northwest side of Little Sandy Lake at the mouth of a north / south trending flow channel running through this wetland complex.

Culvert Inflow – represents tributary flow from the north entering the east end of Sandy Lake near the discharge into the Sand River. The sample point is roughly 1080 meters upstream from its entrance into Sandy Lake. Water quality sampling results from 2014 showed that there were no significant differences between the Outflow Trib 1 and Culvert Inflow samples, and therefore all 2015 sampling for this source was conducted at the culvert.

Twin Lakes Outflow – is located in the Sand River channel approximately 450 meters downstream from the mouth of the north tributary (characterized by Culvert Inflow / Outflow Trib 1). Water sampled at this location is representative of the total outflow from the Twin Lakes system.

As described in the Plan and detailed below, water samples were routinely obtained from the three inflow sources to Little Sandy Lake, the inflow to Sandy Lake (Culvert Inflow), mid-lake sampling locations, and outflow from the system (Twin Lakes Outflow). Analytical results from these monthly sampling events are tabulated by Event Date as well as by Sample Location in Appendix D (see **Figure 3** for sampling locations).

In addition to the routine water quality samples collected by U. S. Steel during 2015 and described above, representatives of the 1854 Treaty Authority also collected water quality samples from a number of Twin Lake sources on a bimonthly basis. This additional water quality data is provided in Appendix D and shown in comparison to equivalent Plan sample sources where possible. The August and October water quality data generated from 1854 Treaty Authority sampling events can be directly compared to those derived from U. S. Steel sampling because of the proximity in sample dates / times. The August sampling events were separated by a single day, while the October sampling events occurred on the same day. Inspection of the two data sets indicates essentially equivalent water quality, except for specific conductance and sulfate. For some reason, the 1854 Treaty Authority values for each of these parameters are higher than those from the U.S. Steel samples. It appears that specific conductance for the 1854 Treaty Authority samples was determined in the lab, while those for the U. S. Steel data sets were collected directly at the source in the field, which is standard procedure for NPDES sampling. No explanation is available for the discrepancy in sulfate levels. The only difference between the two sample sets is the laboratory conducting the analyses. It is particularly interesting to note that chloride, which was analyzed by the same EPA Method (300.0) as sulfate, does not show any significant differences between the two data sets.

3.6 Twin Lakes Inflow / Outflow Flow Measurements

Flow measurements were collected concurrent with Twin Lakes water quality sampling events at the Inflow 1, and Culvert Inflow sample locations. Sand River flow was also monitored at the Station 701 monitoring location, i.e., the point at which the Sand River crosses under County Road 306 immediately upstream of U.S. Highway 53, during each sampling event. Flow and water quality monitoring was included in the Plan for Station 701 due to the historical data base available from sampling related to NPDES/SDS Permit MN0057207 (U. S. Steel Minntac Tailings Basin). Discharge through each of the three monitoring locations was gauged using a Marsh-McBirney Model 2000 Flo-Mate to obtain current velocity values at specific cross-sectional intervals. The results of the 2015 monthly discharge monitoring can be found in Appendix E. Flow rates for Inflow 1 are measured at the downstream (north) side of the snowmobile bridge crossing the Sand River at the inlet to Little Sandy Lake.

As noted in Section 3.5 above although it appears from aerial photographs that defined flow channels exist in the two wetlands terminating at Inflow 2 and Inflow 3, it was not possible to gauge flow rates into Little Sandy Lake at these selected monitoring locations. Efforts to establish flow monitoring stations were negated by the absence of a defined channel and / or safe access issues. It appears that during the majority of the year, there is little concentrated flow within the two wetland channels feeding the Inflow 2 and Inflow 3 monitoring locations, and overall inputs are diffuse, entering the lake at multiple points across the width of the wetland complexes. Readily measurable flow in the defined wetland channels likely only occurs during larger precipitation and runoff events.

As can be seen in the flow summary table presented in Appendix E, the measurable sources of inflow that contribute to discharge from the Twin Lakes did not match concurrent discharges measured at Station 701. As expected, there is considerably more discharge through Station 701 than can be accounted for from the four main inflow sources. Some of this discrepancy can be attributed to the inability to measure flow rates from the wetland channels discharging into Little Sandy Lake at the Inflow 2 and Inflow 3 sampling locations. However, it is believed that the discharge from these two wetland inputs is relatively minor in comparison to Inflow 1. The majority of the discrepancy is most likely due to the unnamed Sand River tributary that enters from the south, downstream of Sandy Lake and which drains a relatively large area southeast of the Twin Lakes and north of the continental divide. Monitoring of this source of flow is outside the scope of the Plan.

Although inflows did not match outflow, inspection of the flow balance provided in Appendix E indicates that the measured inputs consistently accounted for roughly 30% of the discharge at Station 701 for the majority of 2015. A significant outlier from this trend is shown for August 21, at which time inflows accounted for over 65% of the flow through Station 701. This is probably an artifact of a relatively large precipitation event that occurred one to two days prior to sampling. Due to the remote nature of the Twin Lakes system, no weather stations or rain gauges are present immediately adjacent to the lakes. Therefore, a Soil and Water Conservation District weather station, located in Section 4 of T59N, R17W, approximately 4 miles east of the steel bridge, has been used to estimate Twin Lakes precipitation. The surrogate weather station reported a total of 1.89" of rain on August 19 and 0.09" of rain the following day. It is likely that an influx of runoff was passing through the Twin Lakes system at the time of monitoring, but had not yet reached Station 701 downstream on the Sand River.

As discussed in Section 2.0 (see Comment 6), the Sand River downstream of Sandy Lake will be resurveyed in the spring of 2016 to determine if any opportunities exist for the establishment of a Twin Lakes outlet flow monitoring location. Safety, relative to access and work within the stream, will be a major consideration.

3.7 TWIN LAKES AQUATIC PLANT SURVEY

An aquatic plant survey was conducted for each of the Twin Lakes on August 18, similar to that completed in 2104. As in 2014, a total of 8 transects, 4 in each lake, were sampled to gauge the diversity and relative density of aquatic macrophytes present. So that comparisons could be drawn from one monitoring season to the next, an attempt was made to duplicate the procedure followed during the aquatic vegetation survey completed in 2014. Please note that a map of the aquatic plant survey was inadvertently omitted from the 2014 Annual Report, but is included here as **Figure 4**.

The general procedures for the 2015 aquatic vegetation survey are as follows. An attempt was made to replicate the transects that were originally selected during the 2014 sampling season. Sampling locations were randomly selected along each transect at regularly-spaced intervals from the initial, near-shore sampling station to the final sampling station toward the center of the lake. The aquatic macrophytes present in the vicinity of each station were sampled, and the location of each sampling station was recorded via GPS. **Figure 5** illustrates the survey transects followed in 2015. Based on depth measurements obtained during the aquatic plant survey and staff gauge observations at the steel bridge, a bathymetric map of the Twin Lakes was also developed (**Figure 6**).

Two methods were used to assess the overall aquatic macrophyte assemblages. The primary sampling method is a technique detailed in the United States Environmental Protection Agency 2012 National Lakes Assessment Field Operations Manual[1].A double headed sampling rake on a rope was tossed off the left side of the canoe and retracted (see **Image 2** below). The percent plant density on the rake was recorded along with the plant taxa and the percent of the sample of each taxon.

In addition to the double-headed rake / rope sampling method, the percent coverage of emergent aquatic macrophytes that were visible by eye from the canoe were field-identified and listed in the field notes for all of the sampling stations with the exception of Transects 1 and 2 of Sandy Lake. The above-water visual observation technique will be used along with the double headed rake / rope sampling method for all subsequent Twin Lake aquatic vegetation surveys. A general summary of the aquatic macrophytes collected from the Twin Lakes during the 2015 aquatic vegetation survey is shown in **Table 1** below. Detailed results of the 2015 aquatic vegetation survey are provided in Appendix F.

Water depth at each of the sampling stations was measured and ranged from 1 to almost 4 feet. The first sampling station of each transect was located near the edge of the lake and depended upon where the narrow leaved cattail (Typha angustifolia) beds started around the periphery. The deepest location sampled on Sandy Lake was 3.25 feet. Very little vegetation was sampled at this depth. The deepest location sampled on Little Sandy Lake was 3.6 feet. Similar to Sandy Lake, very little vegetation was retrieved from sampling locations in Little Sandy Lake deeper than 3.0 feet.

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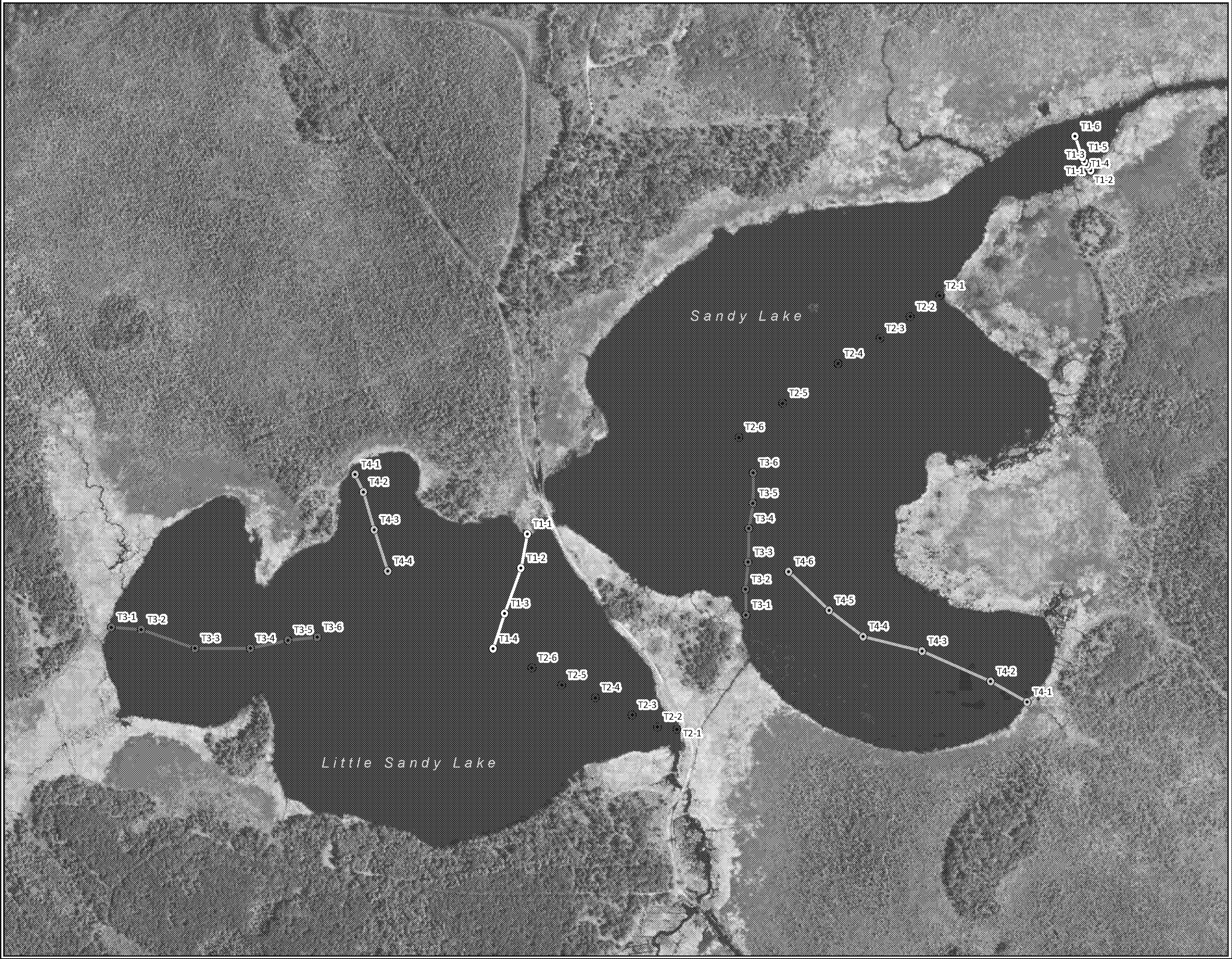
[1] United States Environmental Protection Agency, Office of Water, Washington, D.C., EPA 841-B-11-003, 2012 National Lakes Assessment, Field Operations Manual, Version 1, May 15, 2012.



N

0 250 500 1,000
Feet
1 Inch = 500 Feet

Legend

Plant Survey Transect Sample Point

- Transect 1
- Transect 2
- Transect 3
- Transect 4

Figure 4
Twin Lakes 2014 Aquatic Plant Transect Survey Locations

Twin Lakes
US Steel Corporation -
Minnesota Ore Operations
Mt. Iron, Minnesota (St. Louis County)

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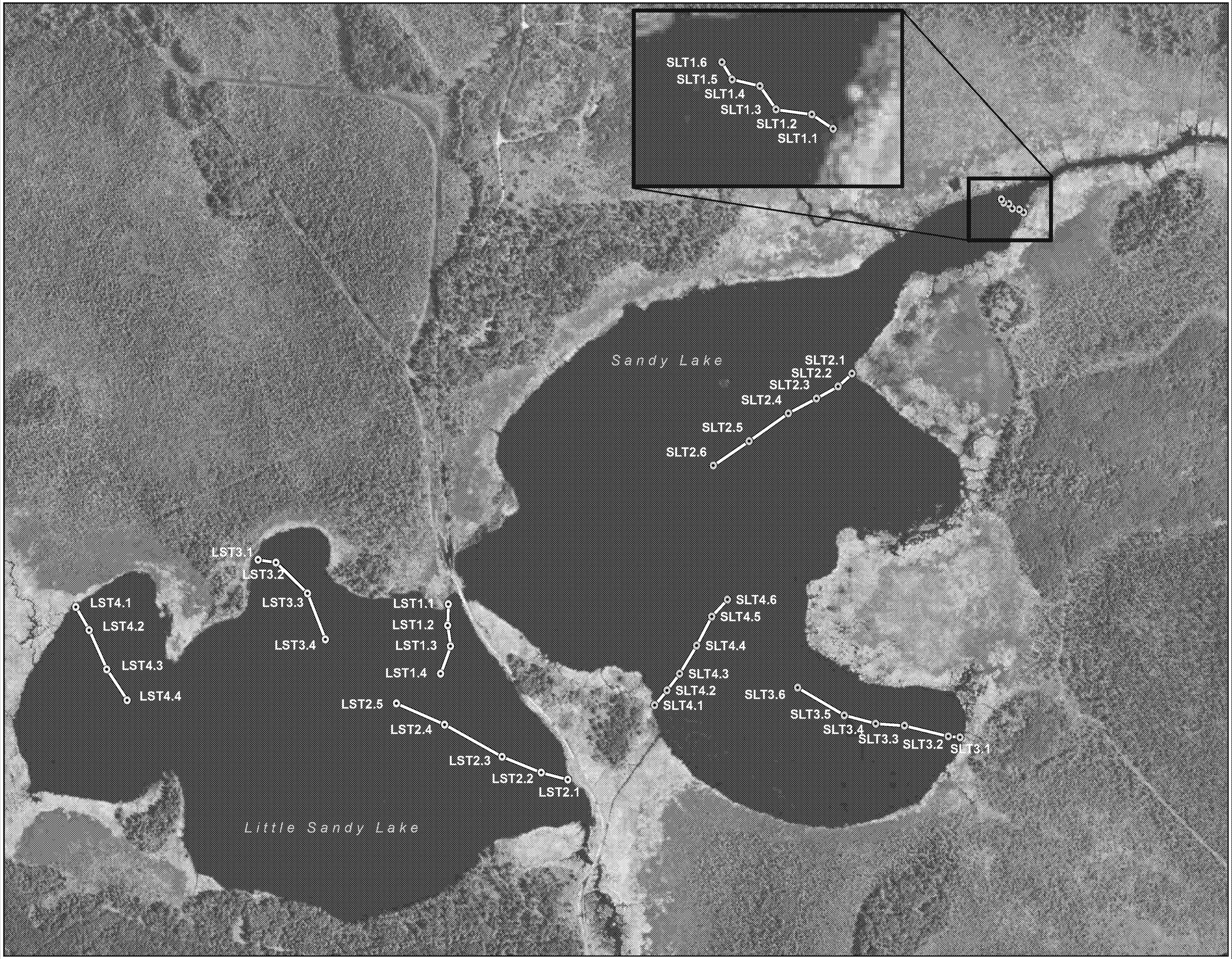

N

0 250 500 1,000

Feet

1 Inch = 500 Feet

Legend

2015 Vegetation Survey Points

- Little Sandy Transect
- Sandy Lake Transect
- 2015 Vegetation Survey Transect

Figure 5
Twin Lakes 2015 Aquatic Plant Transect Survey Locations

Twin Lakes Survey
US Steel Corporation-
Minnesota Ore Operations
Mt. Iron, Minnesota (St. Louis County)

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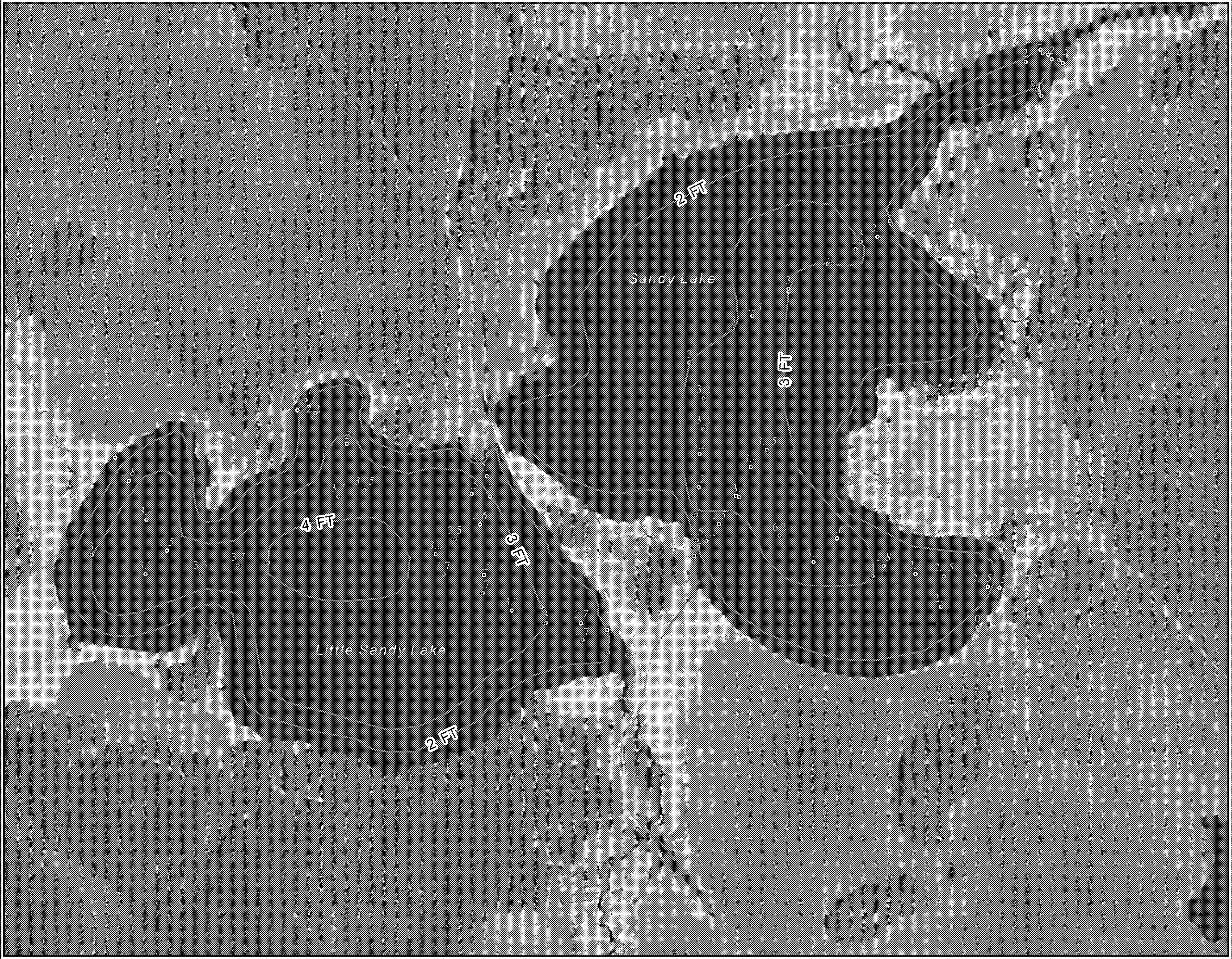

N

0 250 500 1,000
Feet
1 Inch = 500 Feet

Legend

- 2014 Depth Points
- 2015 Depth Points
- Twin Lakes Bathymetry

Notes:

-Bathymetry lines were created by interpretting the shown depths. Actual bathymetry contours may differ from those drawn.
-Depth Data collected on August 18, 2015 and September 11, 2014. The 2014 water depth was corrected to match the 2015 water depth using bridge transducer data
-The water depth according to the Bridge Transducer on August 18, 2015 was 2.40 feet.

Figure 6
Twin Lakes Bathymetry

Twin Lakes Survey
US Steel Corporation-
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Mt. Iron, Minnesota (St. Louis County)

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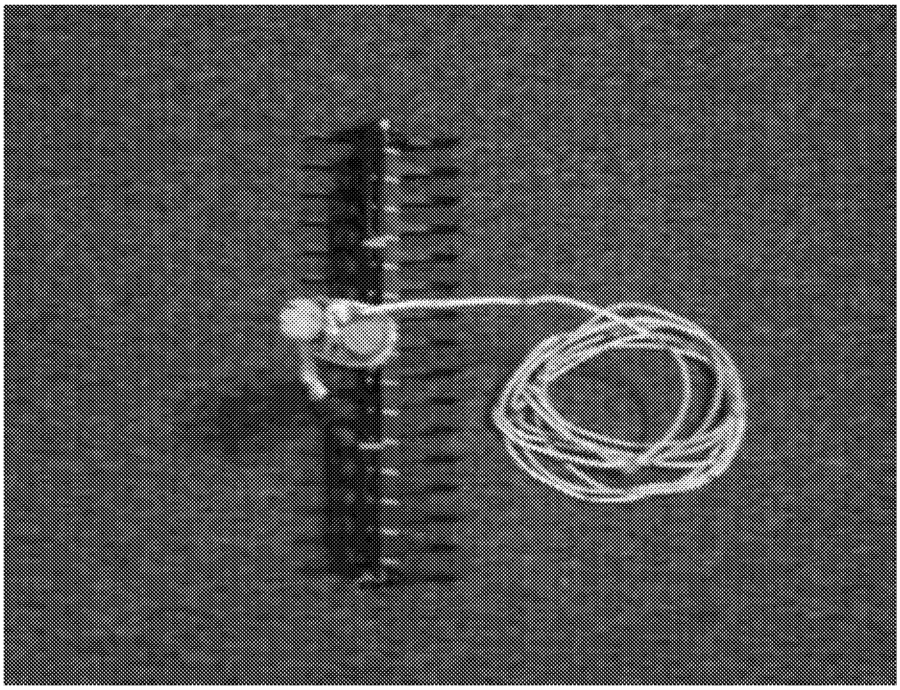

Image 2. Double-headed rake / rope used for aquatic vegetation sampling.

Table 1. Summary of aquatic macrophytes collected during the 2015 Twin Lakes aquatic vegetation survey.

Common Name	**Scientific Name**
Coontail	*Ceratophyllum demersum*
White water lily	*Nymphaea odorata*
Fries' pondweed	*Potamogeton friesii*
Northern watermilfoil	*Myriophyllum exalbescens*
Muskgrass	*Chara spp.*
Sago pondweed	*Stuckenia pectinata*
Clasping pondweed	*Potamogeton richardsonii*
Stiff pondweed	*Potamogeton strictifolius*
Common Bur-reed	*Sparganium eurycarpum*
Filamentous algae	
Water celery	*Vallisneria americana*
Northern bladderwort	*Utricularia intermedia*
Spatterdock	*Nuphar variegata*

A comparison of the 2014 and 2015 survey results does not reveal any major differences in plant assemblages or coverage density. As documented in the 2014 aquatic vegetation survey, all of the aquatic macrophytes sampled during 2015 are taxa native to Minnesota. About the only factor worth noting between the two surveys is the overall depth of the sampling stations. The water levels measured on 8/18/15 were nearly 2 feet lower than those measured on 9/11/14 and 9/15/14.

3.8 Sand River (and Twin Lakes) Beaver and Dam Removal Activities

During the 2014 Plan year, a private animal control contractor was hired to remove beaver and open dams downstream of the Twin Lakes. The effort resulted in measurable, albeit limited, success. As described in the 2014 Annual Report, dams downstream of the Twin Lakes were opened on three separate occasions (May, late June and late September) and there were indications of positive (downward) water level responses each time, as reflected in water depth measurements at the steel bridge. However, in each case beaver returned and rebuilt the dams, resulting in increased lake levels.

Since water depth has been identified as a critical factor in wild rice success, U. S. Steel contracted with a U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) crew based in Grand Rapids, MN, to conduct an intensive beaver and dam removal program in 2015. The contract with APHIS became effective on or about April 1, 2015 and the crew began trapping activities along the Sand River during the second full week of April. The trapping continued into early May and extended from Admiral Lake, at the head of the Sand River system near the Minntac tailings basin perimeter dike, down to County Road 303 (Rice River Road). A total of 43 beavers were removed by the APHIS crew by the first week of May, with an additional 15 – 20 beavers removed by private trappers earlier in the spring (Duane Sahr, personal communication). The APHIS crew noted the presence of several beaver dams along the Sand River downstream of Sandy Lake, with one large dam downstream of U.S. Hwy 53 holding back 4 – 5 feet of water. The crew also revisited the area in late July and confirmed that there were no fresh beaver signs. In summary, the USDA-APHIS crew removed 36 total beaver dams during 2015; 29 dams removed by hand, and seven dams were removed by blasting (John Hart, District Supervisor, USDA-APHIS Wildlife Services, 12/23/2015 email communication).

A separate survey of the Sand River downstream of Sandy Lake was conducted by U. S. Steel and NTS personnel on June 21 to evaluate the presence of beaver dams and pinch points within the Sand River channel. **Figure 7** shows the location of channel obstructions from the June 21 survey. The majority of the channel obstructions were responsible for only small increases in water level immediately upstream. However, in aggregate, the old beaver dams and associated channel debris are causing water levels to be held up in the system, especially after significant rainfall events, as evidenced by the pressure transducer data from the steel bridge. It will be difficult to maintain water levels in the Twin Lakes at optimum depths for consistent wild rice growth given the large number of relic dams and pinch points currently present in the Sand River channel between Sandy Lake and U.S. Hwy 53. It is recommended that the Sand River channel be cleared of some of the more troublesome stretches of submerged woody debris to reduce the amplitude and duration of the "bounce" within the Twin Lakes from runoff after significant rainfall events.

N

0 1,000 2,000 4,000
Feet
1 Inch = 2,000 Feet

Legend

- Beaver Lodge
- Beaver Dam
- Riffle
- Sand River

Note:
-Stream shape downloaded from Minnesota DNR Data Deli

Figure 7
2015 Sand River Beaver Activity Survey Map

Sand River
US Steel Corporation - Minnesota Ore Operations
Mt. Iron, Minnesota (St. Louis County)

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3.9 Wild Rice Re-seeding Process and Procedures

Based on the successful reduction in water levels as a result of the intensive beaver trapping and dam removal program undertaken during the spring and early summer of 2015, a decision was made to pursue limited "pilot-scale" re-seeding efforts in various locations across both lakes. A conference call was arranged and held on August 21 to ensure that interested stakeholders were provided with an opportunity to participate in the planning process for the proposed re-seeding. Representatives of the regional Native American communities (Bois Forte, Fond du Lac, and the 1854 Treaty Authority), as well as the Corps, participated in the call and provided valuable input and advice. The primary topics of discussion during the conference call are provided separately below, along with details associated with each of the topics encountered throughout the process.

Source and amount of wild rice for re-seeding

Abundant stands of wild rice had been observed in the Sand River downstream of Sandy Lake, between Rice River Road (County Road 303) and MN Hwy 169, for the past several years. Therefore, it was proposed that wild rice harvested during 2015 from that section of the Sand River be used as the seed source for any 2015 re-seeding activities. The primary reason for using Sand River seed was that it is likely most genetically similar to wild rice historically present in the Twin Lakes. There was general consensus among the conference call participants that this was an appropriate seed source. Darren Vogt, 1854 Treaty Authority, recommended that re-seeding be conducted at an application rate of 50 – 100 lbs. per acre.

In an effort to obtain wild rice seed, notices were placed in two locations along the Sand River on or about August 22, in areas that would be conspicuous to ricers, advertising the desire to obtain recently harvested wild rice. An advertisement was also placed on the 1854 Treaty Authority Wild Rice web page. One call was received from a ricer on the Sand River. However, the ricer ultimately decided to keep the rice for personal use. Since no sources of Sand River wild rice were secured by the middle of the second week of September, plans were made to harvest rice from Sand River using project personnel.

Seed harvest and storage

Two individuals from U. S. Steel Minntac obtained the required DNR permits and collected wild rice from stands within the Sand River upstream of MN Hwy 169 on September 14, over a period of approximately five hours. The wild rice plant density in the stream was fair to good, but the amount of seed remaining in the heads was sparse, likely due to severe weather and heavy precipitation received approximately 10 days prior (Labor Day weekend). Overall, a total of approximately 40 lbs. of raw wild rice was collected and immediately transported to Northeast Technical Services' Soils Lab in Virginia, MN. At that time, the collected wild rice was weighed, split into six equal volumes, each consisting of about 2850 grams of raw wild rice, and placed into woven poly bags. Each of the six bags of raw rice were then placed into separate 5-gallon plastic buckets and filled with water collected from the Sand River at MN Hwy 169 the previous week. The buckets containing the raw wild rice and Sand River water were then sealed and placed into a climate-controlled room where the air temperature was held at a constant 56°F for the duration of storage.

Permitting requirements

During the August 21 conference call, it was mentioned that re-seeding activities could not proceed without a permit from the DNR. U. S. Steel worked with the DNR and U.S. Forest Service to obtain the required permits (see Appendix I). It should be noted that U. S. Steel could not get a permit for restoration of aquatic vegetation directly. Rather, as per DNR policy, only the landowner can be permitted for this type of activity. The majority of the Twin Lakes shoreline is owned by the federal government as part of the Superior National Forest. As such, U. S. Steel worked with U.S. Forest Service personnel from their Laurentian District, Aurora, MN, office to secure the required permits.

DNR also specified that approval be sought from all minority riparian landowners on the Twin Lakes prior to proceeding with any re-seeding effort. A search of the St. Louis County tax records revealed that, besides the federally-owned land surrounding the majority of the two lakes, there were two privately-held parcels abutting the Twin Lakes, both on Sandy Lake. Letters were subsequently sent to each of the two minority riparian landowners seeking approval for the pilot-scale wild rice re-seeding effort. No response was received from one of the landowners, while the second expressed opposition to the proposed re-seeding because of the potential for damage to the resident fishery from reduced water levels. However, DNR allowed the permit to stay in effect in spite of the minority landowner opposition since, from an agency standpoint, Sandy and Little Sandy lakes are primarily managed for waterfowl.

Spiritual ceremony

Arrangements for a spiritual ceremony to be conducted as part of the re-seeding activities were made with members of the Bois Forte Band of Chippewa. Through the efforts of Bill Latady and Linda Tibbets-Barto, the spiritual ceremony was scheduled for, and held on, the morning of October 23 on a hill overlooking the make-shift canoe landing on the north side of Sandy Lake. Vernon Adams conducted the ceremony in the presence of representatives from Bois Forte, the 1854 Treaty Authority, Corps, U. S. Steel, Northeast Technical Services, and members of the public.

Re-seeding procedures and results

Following the spiritual ceremony and immediately after transporting the ceremony participants back to the vehicle staging area, the pilot-scale re-seeding activities were completed. Three separate areas in each of the two lakes were identified for re-seeding based on anecdotal evidence of previous wild rice areas, and appropriate existing water depths and sediment type (i.e., organic substrate). A couple of the re-seeding plots were subsequently moved from the original plan based on input from area locals familiar with the lakes. **Figure 8** shows locations of the proposed and actual plot re-seeding locations within the Twin Lakes.

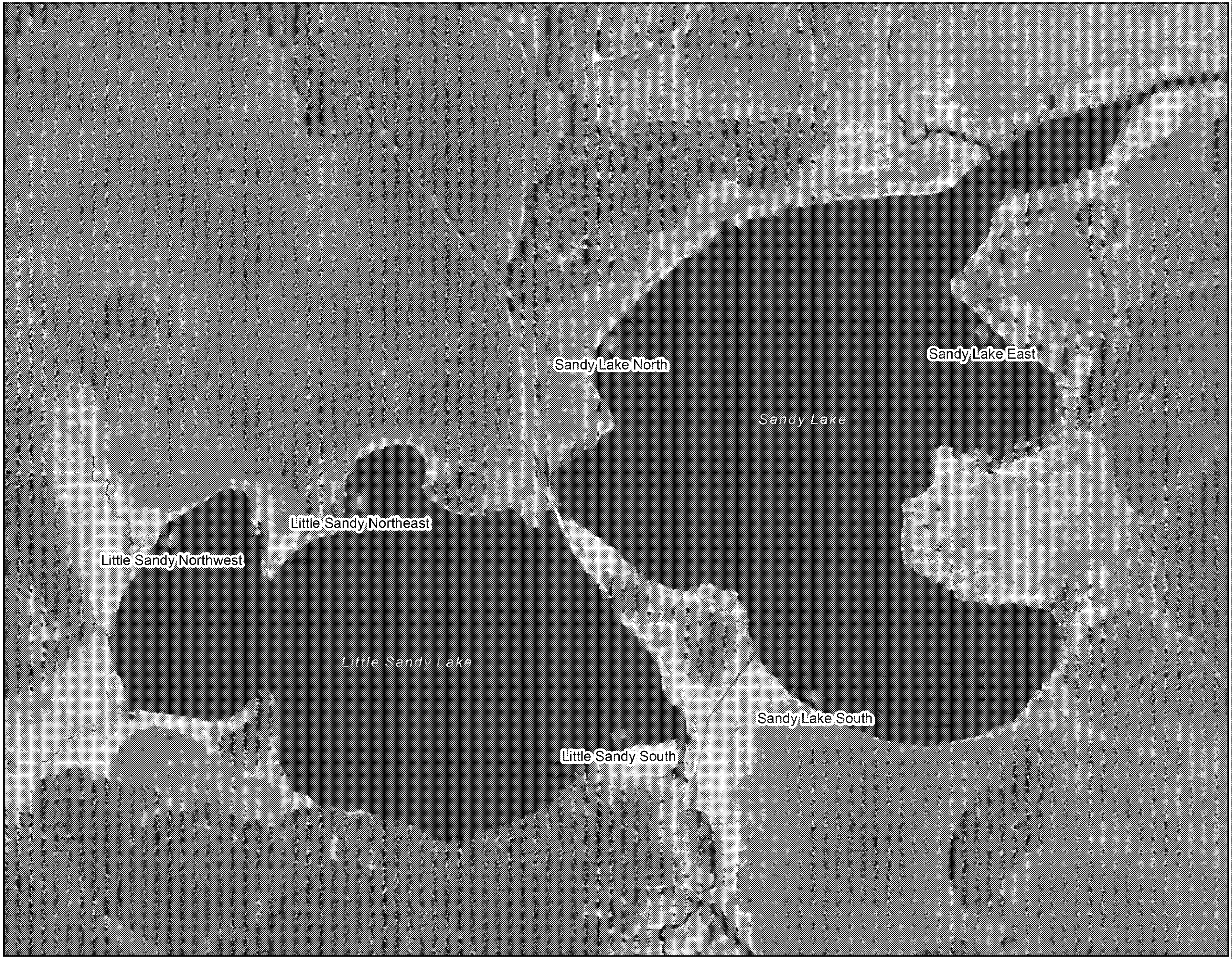

Figure 8
Twin Lakes 2015 Wild Rice Seeding Areas

Twin Lakes Survey
US Steel Corporation-
Minnesota Ore Operations
Mt. Iron, Minnesota (St. Louis County)

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4.0 2016 Twin Lakes Work (Planned)

A general summary of the work proposed for 2016 in support of The Plan is shown in Appendix J. Details of the major components of the 2016 work plan are described separately below.

4.1 Rainfall, Water Level and Temperature Monitoring

Continuous water depth measurements will again be recorded using the PT during the 2016 monitoring season (ice-out until freeze-up). The PT will be placed in the same location at the steel bridge between Little Sandy and Sandy lakes at ice-out in the spring of 2016 as during previous deployments and will be retrieved prior to freeze-up during the fall of 2016. Further, during each planned sampling / monitoring event, water level and temperature data will be downloaded to ensure that the data is being recorded as planned. Additionally, a new weather station was installed in the Minntac Tailings Basin and began operating in September 2015. The weather station was set up on the roof of the Tailings Basin Reclaim Pumphouse, which is located approximately 2 miles due south of the steel bridge. This new meteorological monitoring capability will allow for more accurate measurement of local precipitation events, as well as local evaporation rate data, and will be used in conjunction with PT data to help define lake level fluctuations.

4.2 Sediment and Pore Water Sampling and Analysis

Because of the critical value of this particular component of the Plan, the wild rice bioassay will be repeated in 2016 using an amended protocol (see Section 3.2), i.e., one in which the lake sediment is maintained under conditions as close to field conditions as possible during the bioassay set-up phase. This amended wild rice sediment bioassay will use all possible methods of mitigating atmospheric exposure and maintenance of sediment and pore water characteristics. This may include manual sediment manipulation in an air-tight glove box under nitrogen headspace. Additional sediment cores were obtained from Little Sandy and Sandy lakes during the 2015 field sampling season for use in the amended wild rice sediment bioassay (see **Figure 1**).

During July – October 2015, measured concentrations of pore water sulfide and extractable iron concentrations were inversely correlated (Appendix B); pore water sulfide concentrations tended to increase as pore water extractable iron concentrations tended to decrease. This suggests that a seasonal influence may exist; late-Spring / early-Sumer pore water sulfide concentrations may be near or below the low-end detection limit in the sampled areas of Little Sandy and Sandy Lakes. Peepers are scheduled to be deployed during April 2016, or immediately following ice-out, within the Twin Lakes in roughly the same locations as 2015. Monthly pore water samples using peepers are scheduled to be collected throughout the 2016 field season. Earlier peeper deployment will help answer questions about potential seasonal influences on pore water sulfide and extractable iron concentrations.

As discussed in Section 3.4 above, sediment core samples were obtained for completion of a '100 Year Pollen Count' in 2014. Although sediment cores for this analysis were obtained during 2014, the '100 Year Pollen Count' was initiated in 2015, and is scheduled to conclude in 2016.

4.3 Continued Wild Rice / Aquatic Plants Survey within Twin Lakes System

Efforts to characterize the Twin Lakes in terms of wild rice presence, and density if present, will continue during each 2016 field visit. An aquatic plant survey will be completed at the height of the growing season in both Little Sandy and Sandy lakes during 2016, likely in mid-August. Repeat aquatic plant surveys may help inform future restoration efforts.

4.4 Continued Inflow / Outflow Flow Measurements, Water Quality Sampling, and Characterization Efforts

Water quality and quantity sampling and monitoring will continue on a monthly basis during the 2016 field monitoring season, following the practice established in 2014 and continued in 2015. Monthly water quality samples will be collected at Inflow 1, Inflow 2, Inflow 3, the Culvert, and Twin Lakes Outflow. In addition, samples from Station 701 and the middle of each lake will be collected for an abbreviated list of parameters, consisting of the major cations and anions, as well as field data. Flow monitoring will continue at Inflow 1, the Culvert, and Station 701. In response to a comment by Corps reviewers, an additional flow monitoring location nearer the Twin Lakes Outflow sampling location will be investigated. This would allow for a more accurate water balance within the Twin Lakes and provide a better idea of the relative magnitude of inflow at the Inflow 2 and Inflow 3 monitoring locations. Water quality and flow results will be compared to the 2015 and baseline 2014 data so that characterization efforts may continue. Analytes which were found to be below detection during previous sampling seasons will be included on the analyte list for 2016, but only during two sampling events (May and August).

4.5 Continued Beaver Trapping and Water Level Control

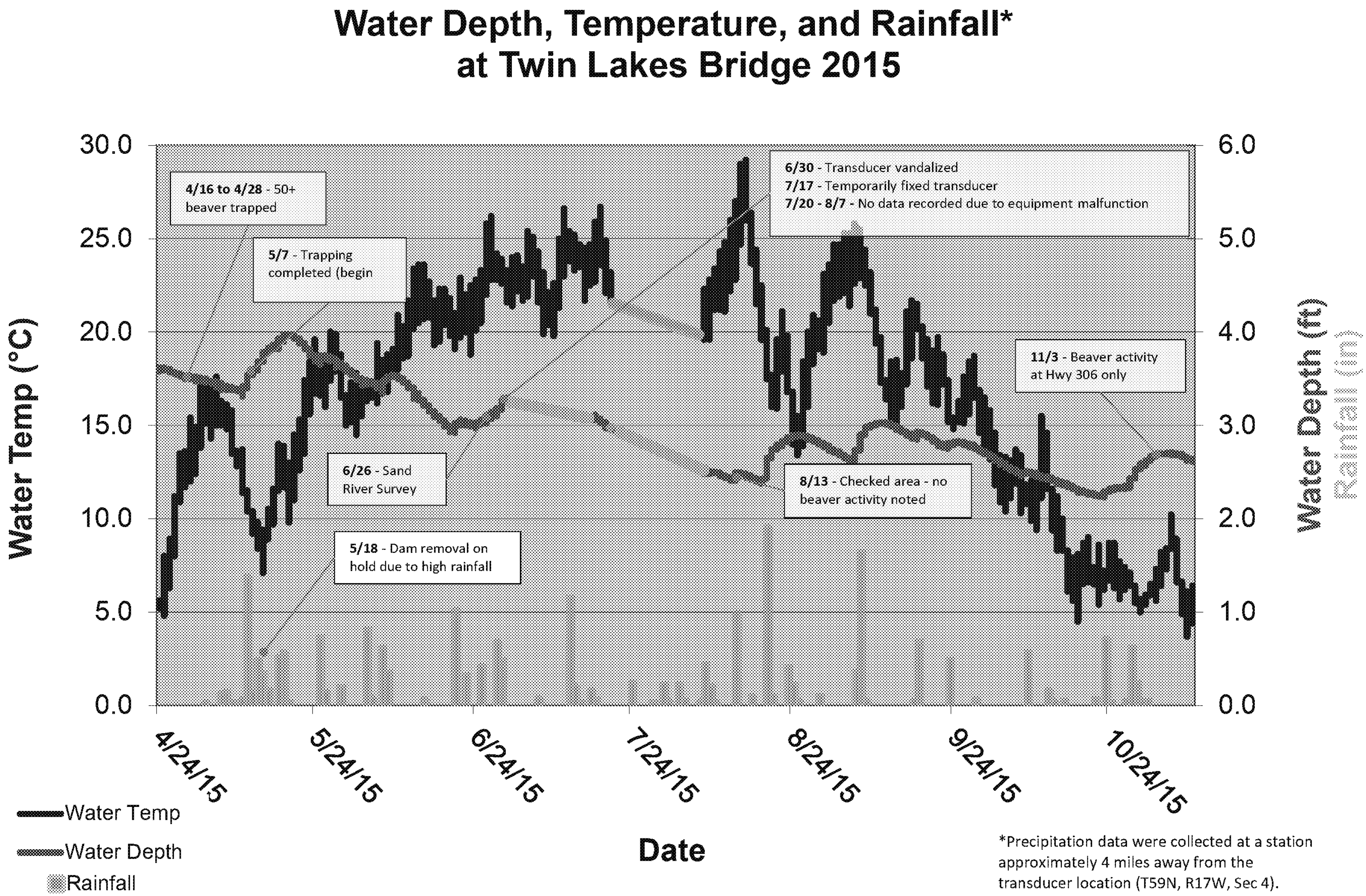
Continued management of lake water depths suitable for wild rice growth is critical to successful restoration of wild rice in the Twin Lakes system. To ensure that the water depth management measures realized during 2015 are maintained, USDA APHIS will again be contracted for beaver and dam removal as needed. Specifically, the APHIS crew will be charged with removing any beaver that may have returned / moved in to the Sand River channel area, especially from the outlet of Sandy Lake downstream to approximately one mile east of U.S. Hwy 53. They will also be responsible for removing significant obstructions to flow along the Sand River mainstem soon after ice out and again during the early summer timeframe, following the period of above average rainfall typical to this area.

4.6 Consideration of Additional Wild Rice Re-seeding

Based on the results of the pilot-scale re-seeding efforts completed in October 2015 and discussed in Section 3.9 above, U. S. Steel may undertake similar re-seeding efforts in 2016. Although these are preliminary plans and subject to change depending upon circumstances encountered during the 2016 field season, it is envisioned that additional re-seeding will be pursued. Following the procedures established in 2015, wild rice seed would be harvested from the Sand River upstream of MN Hwy 169, and stored in water collected from the Sand River in a climate-controlled environment prior to the actual re-seeding. U. S. Steel will seek the input of representatives of the regional Native American bands prior to making any final re-seeding plans for 2016.

APPENDIX A

2015 TWIN LAKES RAINFALL, CONTINUOUS WATER LEVEL AND TEMPERATURE MEASUREMENTS



*Precipitation data were collected at a station approximately 4 miles away from the transducer location (T59N, R17W, Sec 4).

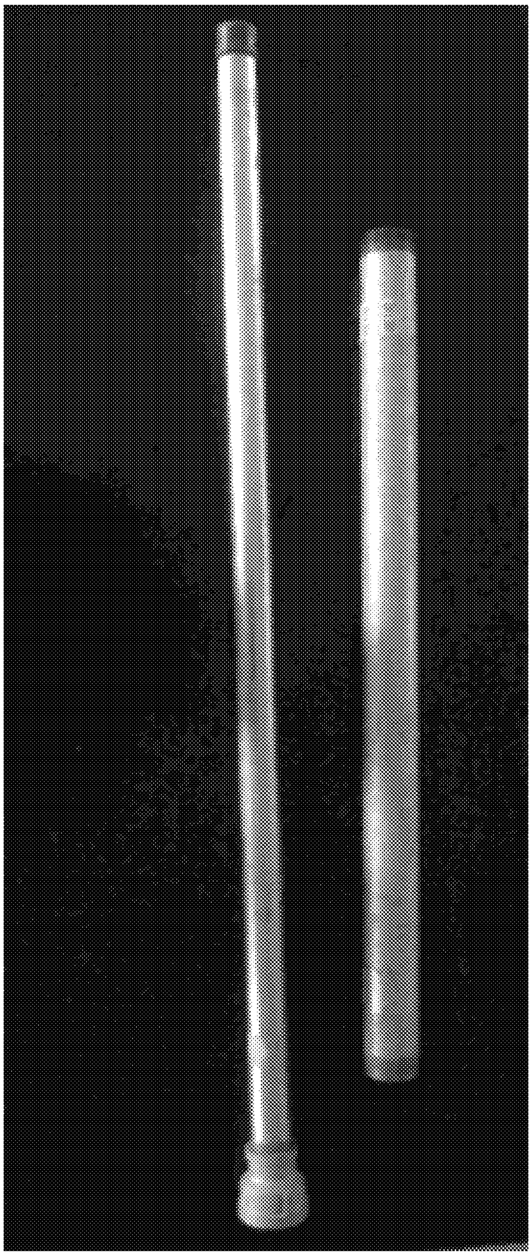
APPENDIX B

TWIN LAKES 2015 SEDIMENT CORE AND PORE WATER RESULTS

TWIN LAKES PEEPER SEDIMENT POREWATER RESULTS

PARAMETER	UNITS	DATE	Twin Lakes Outflow	Sandy Lake Mid	Little Sandy Lake Outlet	Little Sandy Lake Inflow 1	Little Sandy Lake Inflow 2	Little Sandy Lake Inflow 3	Field Blank	MDL
Sulfide	mg/L	8/5/2015	<DL	0.115	0.077	0.045	2.55	0.014		0.01
		9/3/2015	0.572	0.079	5.8	1.815	1.265	4.457	<DL	
		10/2/2015	0.44	0.871	3.23	3.18	7.7	7.12		
Chloride	mg/L	8/5/2015	6.46	23.73	50.37	41.56	58.97	28.25		0.05
		9/3/2015	6.28	29.82	44.94	42.91	62.22	27.23	0.51	
		10/2/2015	5.1	37.89	46.38	50.6	53.17	26.82		
Arsenic, Dissolved	mg/L	8/5/2015	<DL	<DL	<DL	<DL	<DL	<DL		0.03
		9/3/2015	<DL	<DL	0.033	<DL	<DL	<DL	<DL	
		10/2/2015	NM	NM	NM	NM	NM	NM		
Boron, Dissolved	mg/L	8/5/2015	<DL	<DL	0.061	0.049	0.101	<DL		0.025
		9/3/2015	<DL	<DL	0.051	<DL	0.101	<DL	<DL	
		10/2/2015	<DL	0.05	0.473	0.044	0.103	0.026		
Calcium, Dissolved	mg/L	8/5/2015	26.68	23.88	57.24	39.4	92.31	28.13		0.01
		9/3/2015	24.99	31.39	49.64	30.53	104.9	31.6	0.44	
		10/2/2015	34.91	45.41	47.7	44.41	109.92	39.98		
Cobalt, Dissolved	mg/L	8/5/2015	<DL	<DL	<DL	<DL	<DL	<DL		0.004
		9/3/2015	<DL	<DL	<DL	<DL	<DL	<DL	<DL	
		10/2/2015	<DL	<DL	<DL	<DL	<DL	<DL		
Copper, Dissolved	mg/L	8/5/2015	<DL	<DL	<DL	<DL	<DL	<DL		0.004
		9/3/2015	<DL	<DL	<DL	<DL	<DL	<DL	<DL	
		10/2/2015	<DL	<DL	<DL	<DL	<DL	<DL		
Iron, Dissolved	mg/L	8/5/2015	3.243	8.72	0.78	5.586	0.174	1.763		0.025
		9/3/2015	0.892	0.15	0.205	1.049	<DL	0.814	<DL	
		10/2/2015	1.18	0.027	1.212	0.198	0.026	0.317		
Potassium, Dissolved	mg/L	8/5/2015	4.813	5.904	8.683	6.762	7.453	4.602		0.1
		9/3/2015	4.431	5.137	8.104	6.223	7.277	4.508	<DL	
		10/2/2015	5.863	4.627	8.029	7.243	7.217	5.42		
Magnesium, Dissolved	mg/L	8/5/2015	10.85	17.72	45.78	33.07	107.3	25.49		0.01
		9/3/2015	9.249	32.89	39.63	23.86	122.1	23.43	0.124	
		10/2/2015	13.45	59.34	42.53	45.07	124.2	41.46		
Manganese, Dissolved	mg/L	8/5/2015	0.384	1.621	0.266	0.468	0.037	0.304		0.005
		9/3/2015	0.398	0.031	0.214	0.392	0.006	0.377	<DL	
		10/2/2015	0.98	<DL	0.427	0.222	0.018	0.799		
Sodium, Dissolved	mg/L	8/5/2015	5.325	13.79	28.91	23.83	35.42	13.66		0.05
		9/3/2015	4.576	16.97	26.27	21	37.92	15.42	0.196	
		10/2/2015	4.972	25.76	27.4	28.02	39.64	20.13		
Lead, Dissolved	mg/L	8/5/2015	<DL	<DL	<DL	<DL	<DL	<DL		0.025
		9/3/2015	<DL	<DL	<DL	<DL	<DL	<DL	<DL	
		10/2/2015	<DL	<DL	<DL	<DL	<DL	<DL		
Sulfur, Dissolved	mg/L	8/5/2015	3.235	4.711	17.39	22.37	116.6	5.583		0.05
		9/3/2015	3.882	18.6	6.722	7.026	84.52	2.986	0.167	
		10/2/2015	2.122	71.35	2.474	7.199	52.3	5.546		
Strontium, Dissolved	mg/L	8/5/2015	0.085	0.081	0.19	0.15	0.287	0.114		0.01
		9/3/2015	0.078	0.112	0.17	0.123	0.328	0.139	<DL	
		10/2/2015	0.115	0.171	0.171	0.158	0.334	0.147		
Zinc, Dissolved	mg/L	8/5/2015	<DL	0.01	<DL	<DL	<DL	<DL		0.005
		9/3/2015	0.021	0.074	0.116	0.03	0.025	0.03	0.032	
		10/2/2015	0.011	0.008	0.013	0.009	<DL	<DL		
Sulfate	mg/L	8/5/2015	5.05	8.02	41.28	51.37	174.17	12.24		0.03
		9/3/2015	12.94	59.59	19.45	25.53	294.34	14.01	1.98	
		10/2/2015								

<DL - Below lab detection limit
NM - Not measured



Sediment coring assembly. Thirty-six inch long plastic core sleeve inserts fit into the larger diameter component (on right; three feet long). Total legth of assembly = approx. eight feet; core sleeves are three feet long.

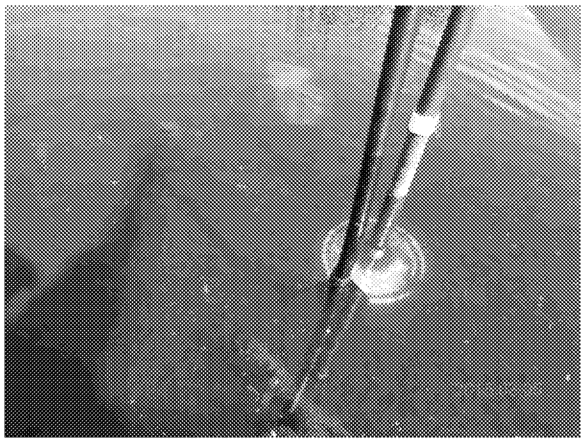
Sediment pore water sampling device ('peeper'). The white ‘bucket lid’ is positioned to sit on top of the sediment, allowing submersion of the four, 50 mL centrifuge tubes within the top 10 cm of sediment.

TWIN LAKES PEEPER DEPLOYMENT PICTURES – AUGUST 2015

Peeper deployed at Twin Lakes Outflow in the Sand River.

Peeper deployed at Little Sandy Lake Inflow 2 location.

Peeper deployed at Sandy Lake mid location.



Peeper deployed at Little Sandy Lake Inflow 3 location.

Peeper deployed at Little Sandy Lake outflow location.

Peeper deployed at Little Sandy Lake Inflow 1 location.

Sediment Core Analysis / Evaluation. Dr. Peter Lee, Lakehead University, Thunder Bay, Ontario, CA.

Values for all sediment cores by 5 cm sections (top of sediment to 25 cm core depth) for Sandy and Little Sandy Lakes are contained in Appendix A. The results for both total and pore water values are summarized in Tables 1 and 2 and compared to data collected by the MPCA during 2011 (Myrbo et al, 2012) and other data from wild rice lakes in Ontario. Not all the same parameters as per the twin lakes were collected for the comparison data, but they do provide a useful comparison.

Comparing total values (Table 1) in the top 5 cm layer for Sandy versus Little Sandy, Little Sandy had noticeably higher values for AVS, Bo, Fe, Mn, and S and lower values for SEM. Other parameters were similar in values. Both lakes had values for Fe, S, AVS, Mn, and Pb decline considerably from the top 5 cm layer to the 6-10 cm layer. This declining trend continued to the 21-25 cm layer with S levels lower by a factor of 10 and Fe by a factor of 5 at these depths in the sediment. Presumably the concentrations for these chemical constituents at the lower depths were reflective of original background levels prior to mining operations.

Compared to values found by Myrbo et al. (2012) and the Ontario data, values in Sandy and Little Sandy sediment for Moisture, As, Cd, Co, Cu, Mn, Pb, and Zn were all within the ranges found elsewhere. AVS, Fe, and S were above the ranges.

Table 2 contains the pore water values for Sandy and Little Sandy Lakes in comparison to the MPCA data and that of Jorgenson (2013). Cl values were somewhat elevated in the Twin Lakes versus the comparison data but were in range for Ca, Fe, K, Mg, Na and Sr. Comparing the 21-25 cm layer in Sandy Lake (this layer was not available for Little Sandy Lake), there was a noticeable decline in values for K, Fe, Mn, Na, S, and SO_4 from the top layer. Although changes in Fe, Mn, S and SO_4 could be attributed to mining activities, the declines in K and Na were similarly found in natural sediment cores by Jorgenson (2013). Most of the values for sulfides (Appendix A) were below detection limits versus those found by Myrbo et al. (2012). This may reflect the fact that the MPCA collected sulfides *in situ* at their field sites. This same approach will be done at the Twin Lakes in 2015 to see if sulfide values differ when sampled directly.

In terms of whether or not the sediments in Sandy and Little Sandy will support wild rice growth, it will depend on the effects on growth of the elevated values of metals and sulfur compounds present versus normal concentrations in lake sediments. Ideally, a bioassay for wild rice growth that examined site specific effects could be used to test the wild rice response, but this is not available. MPCA (2014) in the draft analysis for scientific peer review suggested that sulfides were responsible for wild rice growth reduction. They further correlated the presence of sulfides to iron concentrations. If iron in pore water were sufficiently high, no sulfides would be expected. In both Sandy and Little Sandy Lakes, elevated sulfur levels in the sediment also correlated to elevated iron levels. The MPCA (2014) also determined there was a significantly positive correlation of AVS, standardized with total organic carbon, versus sulfate in surface waters. This relationship could potentially be used to determine if there was sufficient iron present to counter the increases in sulfides. Again, a bioassay of the response of wild rice in the twin lake sediments would be a true test of whether or not there was sufficient iron present to buffer the production of detrimental sulfides.

References:

Jorgenson, K. 2013. Northern wild rice (*Zizania palustris* L.) as a phytoremediation species in eutrophic wetlands – investigation of root-sediment interactions. M.Sc. Thesis, Lakehead University, Thunder Bay, ON. 270 pp.

Minnesota Pollution Control Agency, 2014. Analysis of the wild rice sulfate standard study: draft of scientific peer review. 91 pp.

Myrbo, A., Ramstack, J., and R. Thompson. 2012. Wild rice sulfate preliminary field survey 2011. University of Minnesota. Prepared for MPCA. 150 pp.

Table 1. Total values (digested) for parameters in sediment cores collected from Sandy and Little Sandy Lakes compared to other studies (Myrbo et al. 2012; Jorgenson, 2013; Whitefish, unpublished, LUEL).

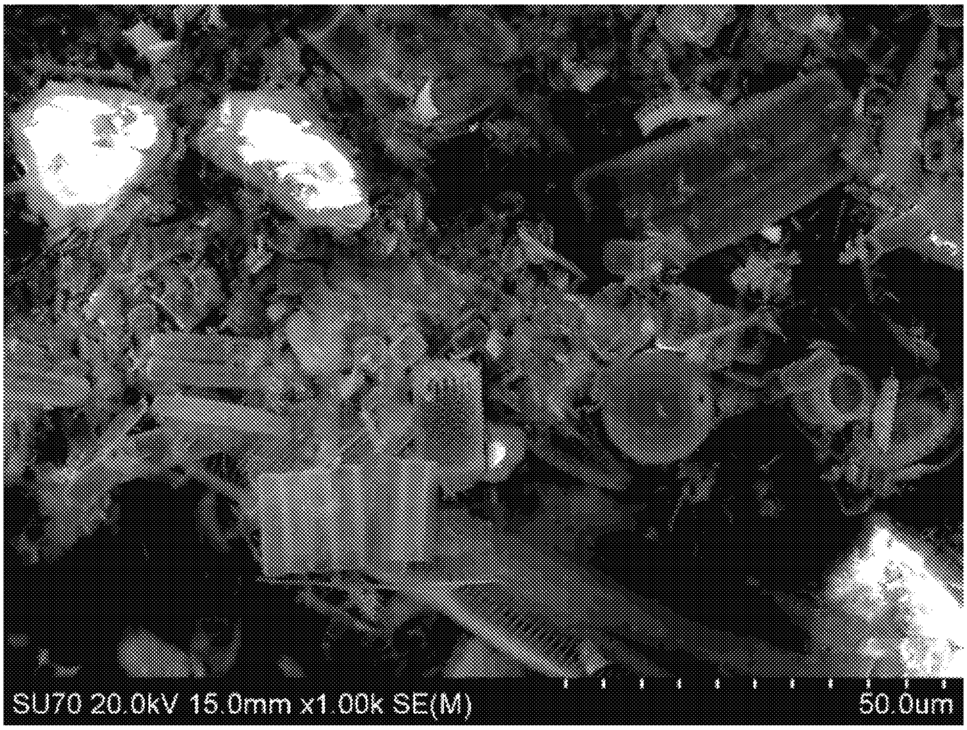
Parameter			Sandy Lake			Little Sandy Lake			Mybro	Mybro	Mybro	Whitefish	Jorgenson
	MDL	UNITS	0 - 5 cm	6 - 10 cm	21 - 25 cm	0 - 5 cm	6 - 10 cm	21 - 25 cm	(mean)	(min)	(max)		
% Moisture Content	n / a	%	86.87	82.26	85.41	86.7	85.34	83.26	76.50	20.10	96.00		
Acid Volatile Sulfides	0.0001	%	0.034	0.024	0.005	0.192	0.083	0.0051					
Acid Volatile Sulfides	0.003	umole / g	10.71	7.53	1.64	60.0	25.93	1.60	0.72	0.00	6.25	1.90	
SEM [Cd,Cu,Ni,Pb,Zn]	0.002	umole / g	0.991	0.733	0.916	0.125	0.112	0.084				1.390	
Bulk Density	0.05	g / cm3	0.12	0.19	0.12	0.16	0.18	0.21					
Total Recoverable Arsenic in sediment	2	ug / g	9.63	6.99	5.01	9.6	8.79	4.02	2.64	0.44	11.92		1.00
Total Recoverable Boron in sediment	2	ug / g	28.7	17.71	20.37	61.58	45.12	44.63					
Total Recoverable Cadmium in sediment	0.25	ug / g	0.80	1.014	0.93	0.35	0.83	0.53	0.37	0.02	0.88	1.66	
Total Recoverable Cobalt in sediment	0.2	ug / g	8.04	6.10	5.14	5.83	6.09	5.75	2.11	0.19	10.26	0.71	
Total Recoverable Chromium in sediment	0.03	ug / g	19.62	19.76	21.07	17.76	21.76	24.30				7.07	
Total Recoverable Copper in sediment	0.05	ug / g	11.47	11.67	12.2	9.69	11.94	11.62	7.19	0.68	22.65	25.84	
Total Recoverable Iron in sediment	0.1	ug / g	59414.6	35683.6	15315.47	68833.9	39081.4	13125.70	8328.4	1298.4	50389.0	7852.65	1210.0
Total Recoverable Manganese in sediment	0.05	ug / g	436.62	298.25	259.38	624.39	267.45	181.91	608.60	45.52	3814.96	135.41	134.25
Total Recoverable Molybdenum in sediment	2	ug / g	< DL	< DL	< DL	< DL	< DL	< DL					
Total Recoverable Nickel in sediment	0.2	ug / g	12.55	13.04	14.86	8.44	11.4	14.30				8.43	
Total Recoverable Lead in sediment	1	ug / g	30.18	22.20	6.30	33.36	23.36	4.95	11.11	0.60	76.64	13.42	
Total Recoverable Sulfur in sediment	1	ug / g	47172.4	28590.4	6374.58	64517.3	32975.5	4071.13	3116.0	55.0	12515.0	247.19	4519.0
Total Recoverable Selenium in sediment	2	ug / g	< DL	< DL	< DL	< DL	< DL	< DL					
Total Recoverable Zinc in sediment	0.03	ug / g	98.36	92.20	75.23	68.16	82.90	61.61	38.05	4.92	103.98	49.70	75.14
Total Carbon in sediment	0.01	%	20.63	18.71	24.50	17.31	16.76	18.23					
N in sediment	0.01	%	1.72	1.47	1.69	1.7	1.43	1.32					

Table 2. Pore water values for parameters in sediment cores collected from Sandy and Little Sandy Lakes compared to other studies (Myrbo et al. 2012; Jorgenson, 2013).

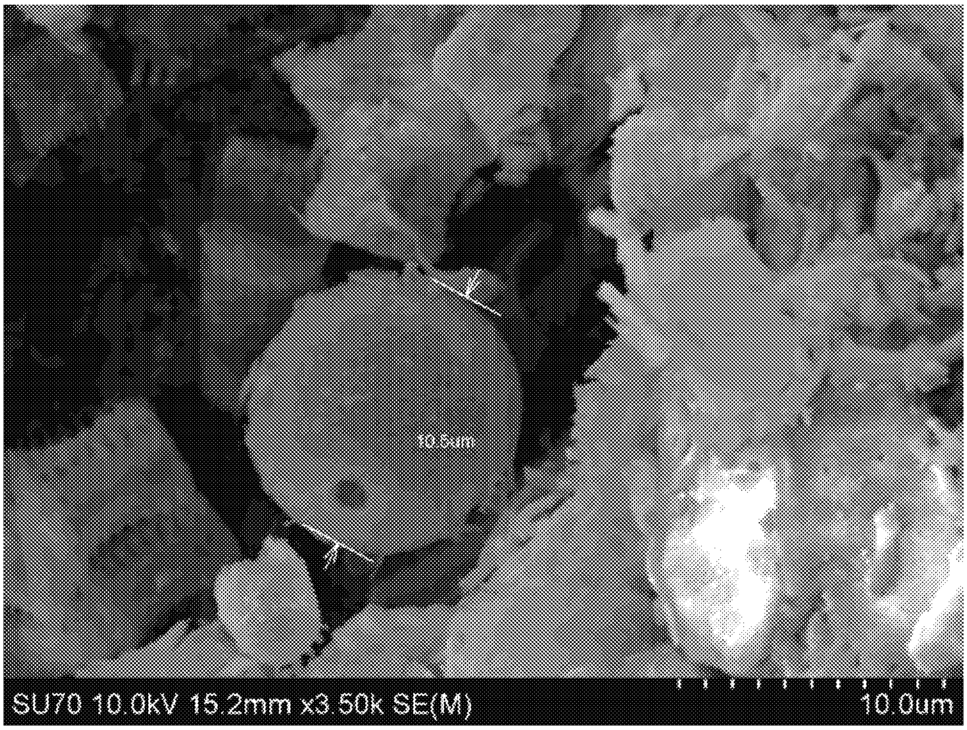
Parameter	MDL	UNITS	Sandy Lake 0 - 5 cm	Sandy Lake 21 - 25 cm	L. Sandy 0 - 5 cm	Mybro (mean)	Mybro (min)	Mybro (max)	Jorgenson
Sulfide(S2-) in porewater	0.01	mg / L	<DL	<DL	0.223	0.305	0.01	14.84	
Chloride (IC) in porewater	0.05	mg / L	38.00	46.97	56.98	21.85	4.91	36.36	
Dissolved Arsenic in porewater	0.05	mg / L	<DL	<DL	<DL				
Dissolved Boron in porewater	0.05	mg / L	0.052	<DL	0.071				
Dissolved Calcium in porewater	0.01	mg / L	45.8	11.80	69.82	50.4	24.54	80.77	39.96
Dissolved Cadmium in porewater	0.002	mg / L	<DL	<DL	<DL				
Dissolved Cobalt in porewater	0.004	mg / L	<DL	<DL	<DL				
Dissolved Chromium in porewater	0.002	mg / L	<DL	<DL	<DL				
Dissolved Copper in porewater	0.004	mg / L	<DL	<DL	<DL				
Dissolved Iron in porewater	0.025	mg / L	1.642	0.997	0.552	10	0.012	35.59	1.735
Dissolved Potassium in porewater	0.1	mg / L	11.296	3.263	12.42	3.43	0.03	26.68	0.75
Dissolved Magnesium in porewater	0.01	mg / L	44.26	10.251	75.21	26.67	7.80	134.38	7.91
Dissolved Manganese in porewater	0.005	mg / L	0.539	0.211	0.334	1.97	0.025	16.72	0.313
Dissolved Molybdenum in porewater	0.05	mg / L	<DL	<DL	<DL				
Dissolved Sodium in porewater	0.05	mg / L	24.57	9.979	37.06	7.2	0.06	92	5.16
Dissolved Nickel in porewater	0.025	mg / L	<DL	<DL	<DL				
Dissolved Lead in porewater	0.025	mg / L	<DL	<DL	<DL				
Dissolved Sulfur in porewater	0.05	mg / L	23.639	5.00	51.19				0.4
Dissolved Selenium in porewater	0.05	mg / L	<DL	<DL	<DL				
Dissolved Strontium in porewater	0.01	mg / L	0.165	0.053	0.248	0.166	0.067	0.511	0.104
Dissolved Zinc in porewater	0.005	mg / L	0.019	0.016	0.007	0.061	0.01	0.275	0.005
Sulphate (SO4) [IC] in porewater	0.03	mg / L	69.19	42.04	145.39				

APPENDIX C

TWIN LAKES SEDIMENT CORE 100 YEAR POLLEN COUNT



Pollen grain image from Sandy Lake sediment core - SL1 location.



Pollen grain image from Sandy Lake sediment core - SL1 location (enlarged).

Appendix D

Twin Lakes 2015 Inflow / Outflow Water Sampling Data

2015 Twin Lakes Water Quality Monitoring
Comparison of analytical results - 1854 Treaty Authority Compared with USS

Twin 1 - inlet to Little Sandy Lake

		1854	*USS*	*1854*	*USS*	*1854*	*USS*
	Units	6/25/2015	6/12/15	8/20/2015	8/21/15	10/19/2015	10/19/2015
Alkalinity (as CaCO3)	mg / L	148	137	122	163	244	233
Chloride	mg / L	58	42.8	50	51.3	86	85.4
Color	Pt-Co	70		50		60	
Nitrogen, Ammonia	mg / L	<0.01	<0.10	<0.01	NM	0.05	<0.10
Nitrogen, Nitrate + Nitrite	mg / L	<0.01		<0.01		<0.01	
Nitrogen, Total	mg / L	0.7		0.7		0.5	
Nitrogen, Total Kjedahl	mg / L	0.7	0.62	0.7	0.53	0.5	<0.5
pH	SU	7.4	6.9	7.0	7.7	7.7	7.4
Phosphorus, Total	mg / L	0.017		0.029		0.017	
Solids, Suspended Volatile	mg / L	<1		2		<1	
Solids, Total Dissolved	mg / L	730	594	840	799	1070	1040
Solids, Total Suspended	mg / L	<1		4		2	
Specific Conductance	umhos / cm	1080	892	1100	1074	1510	1435
Sulfate	mg / L	386	271	405	366	590	498
Turbidity	NTU	1.0		4.7		5.1	

Twin 2 - center of Little Sandy Lake

		1854	*USS*	*1854*	*USS*	*1854*	*USS*
	Units	6/25/2015	6/12/15	8/20/2015	8/21/15	10/19/2015	10/19/2015
Alkalinity (as CaCO3)	mg / L	124	116	182	160	196	178
Chloride	mg / L	35	31.4	43	40.4	50	47.6
Color	Pt-Co	70		60		80	
Nitrogen, Ammonia	mg / L	<0.01	<0.10	<0.01	<0.10	<0.01	<0.10
Nitrogen, Nitrate + Nitrite	mg / L	<0.01		<0.01		<0.01	
Nitrogen, Total	mg / L	0.7		0.8		0.6	
Nitrogen, Total Kjedahl	mg / L	0.7	0.85	0.8	0.72	0.6	0.81
pH	SU	8.1	7.9	8.5	8.4	8.3	8.4
Phosphorus, Total	mg / L	0.015		0.018		0.019	
Solids, Suspended Volatile	mg / L	1		2		1	
Solids, Total Dissolved	mg / L	500	475	620	622	670	649
Solids, Total Suspended	mg / L	1		2		2	
Specific Conductance	umhos / cm	765	730	915	890	1010	949
Sulfate	mg / L	253	219	273	260	360	279
Turbidity	NTU	2.1		2.0		1.9	

Twin 3 - center of Sandy Lake

		1854	*USS*	*1854*	*USS*	*1854*	*USS*
	Units	6/25/2015	6/12/15	8/20/2015	8/21/15	10/19/2015	10/19/2015
Alkalinity (as CaCO3)	mg / L	107	93.7	119	117	160	153
Chloride	mg / L	33	28.5	31	28.8	40	39.1
Color	Pt-Co	60		70		80	
Nitrogen, Ammonia	mg / L	0.04	<0.10	<0.01	<0.10	<0.01	0.15
Nitrogen, Nitrate + Nitrite	mg / L	<0.01		<0.01		<0.01	
Nitrogen, Total	mg / L	0.7		0.9		0.7	
Nitrogen, Total Kjedahl	mg / L	0.7	0.67	0.9	1.1	0.7	0.86
pH	SU	8.2	8.0	8.4	8.2	8.1	8.1
Phosphorus, Total	mg / L	0.02		0.018		0.024	
Solids, Suspended Volatile	mg / L	<1		<1		1	
Solids, Total Dissolved	mg / L	440	399	450	436	550	546
Solids, Total Suspended	mg / L	<1		1		4	
Specific Conductance	umhos / cm	677	610	663	632	1000	746
Sulfate	mg / L	209	174	171	162	270	223
Turbidity	NTU	1.3		1.2		3.4	

Twin 4 - outlet from Sandy Lake

		1854	*USS*	*1854*	*USS*	*1854*	*USS*
	Units	6/25/2015	6/12/15	8/20/2015	8/21/15	10/19/2015	10/19/2015
Alkalinity (as CaCO3)	mg / L	95	91.1	28	47.4	144	134
Chloride	mg / L	29	27.4	13	12.1	34	35.4
Color	Pt-Co	70		150		90	
Nitrogen, Ammonia	mg / L	<0.01	<0.10	0.01	<0.10	0.02	<0.10
Nitrogen, Nitrate + Nitrite	mg / L	<0.01		<0.01		<0.01	
Nitrogen, Total	mg / L	0.8		0.7		0.6	
Nitrogen, Total Kjedahl	mg / L	0.8	0.58	0.7	0.61	0.6	0.77
pH	SU	7.8	7.5	7.0	7.0	8.0	8.1
Phosphorus, Total	mg / L	0.02		0.023		0.023	
Solids, Suspended Volatile	mg / L	2		<2		<1	
Solids, Total Dissolved	mg / L	360	375	190	174	470	473
Solids, Total Suspended	mg / L	2		2		3	
Specific Conductance	umhos / cm	566	590	249	219	715	666
Sulfate	mg / L	168	163	45.6	33.8	220	192
Turbidity	NTU	2.2		5.4		4.3	

TWIN LAKES
INFLOW / OUTFLOW SAMPLING EVENT
5/22/2015

Analytes - Cations	**Little Sandy Inflow 1**	**Little Sandy Inflow 2**	**Little Sandy Inflow 3**	**Little Sandy Middle**	**Sandy Middle**	**Twin Lakes Outflow**	**Culvert Inflow**	**Reporting Detection Limits**	**Reporting Units**
Aluminum	**29.7**	**15.2**	<10.0	NM	NM	**16.4**	**28.4**	**10.0**	ug / L
Arsenic	<0.50	<0.50	<0.50	NM	NM	<0.50	<0.50	**0.50**	ug / L
Barium	**19**	**23.7**	**26.5**	NM	NM	**24.4**	**17.5**	**10.0**	ug / L
Calcium	**38.4**	**42.6**	**34**	**45.2**	**40.7**	**41.6**	**9**	**0.50**	mg / L
Iron	**407**	**238**	**80**	NM	NM	**287**	**1180**	**50.0**	ug / L
Magnesium	**53**	**62.6**	**55.3**	**64.9**	**57.4**	**58**	**3.2**	**0.50**	mg / L
Manganese	**31.3**	**32.8**	**14.8**	NM	NM	**32.6**	**46.1**	**10.0**	ug / L
Phosphorus	<0.10	<0.10	<0.10	NM	NM	<0.10	<0.10	**0.10**	mg / L
Potassium	**6.27**	**5.73**	**3.38**	NM	NM	**6.03**	**1.88**	**0.25**	mg / L
Rubidium	**2.8**	**3**	**2.6**	NM	NM	**2.8**	**1.4**	**1.0**	ug / L
Sodium	**21.3**	**20.8**	**13.9**	**23**	**22.2**	**22.2**	**3.7**	**0.50**	mg / L
Strontium	**129**	**133**	**101**	NM	NM	**136**	**34.3**	**10.0**	ug / L
Analytes - Anions	==========	==========	==========	==========	==========	==========	==========	==========	==========
Chloride	**31.4**	**29.6**	**15.8**	**33.9**	**33.4**	**33.4**	**8.2**	**1.0**	mg / l
Nitrogen, Kjeldahl, Total	**0.62**	**0.73**	**0.59**	NM	NM	**0.57**	<0.50	**0.50**	mg / L
Ammonium as Nitrogen	NM	NM	NM	NM	NM	NM	NM	**0.050**	mg / L
Sulfate	**191**	**216**	**182**	**223**	**196**	**200**	**2.5**	**2.0**	mg / L
Analytes - Other	==========	==========	==========	==========	==========	==========	==========	==========	==========
Total Dissolved Solids	**457**	**506**	**418**	**530**	**466**	**473**	**97**	**10.0**	mg / L
Alkalinity, Total as CaCO3	**93.1**	**105**	**92.6**	**110**	**96.1**	**97.3**	**24.6**	**10.0**	mg / L
Dissolved Organic Carbon	**12.5**	**12.9**	**14.7**	NM	NM	**10.8**	**11.3**	**1.0**	mg / L
Total Hardness by 2340B	**314**	**364**	**313**	**380**	**338**	**343**	**35.7**	**10.0**	mg / L
UV Absorbance @ 254 nm	**0.429**	**0.408**	**0.468**	NM	NM	**0.36**	**0.478**	**0.009**	cm^{-1}
SUVA	**3.5**	**3.3**	**3.3**	NM	NM	**3.5**	**4.4**	**0.1**	L / mg*m
YSI Probe Plus Data	==========	==========	==========	==========	==========	==========	==========	==========	==========
pH	**7.1**	**7.7**	**7.3**	**8.1**	**8.0**	**7.8**	**6.7**	**± 0.2**	Units
Temperature	**9.8**	**14.2**	**8.5**	**15**	**14.9**	**13.6**	**14.5**	**± 0.1**	°C
Specific Conductance	**632**	**735**	**601**	**775**	**668**	**698**	**85**	**± 1%**	uS / cm
Dissolved Oxygen	NM	NM	NM	NM	NM	NM	NM	**± 0.01**	mg / L

Bold Print indicates the sample is above the detection limit
"<" indicates value below reporting limit
NM indicates that the analyte was not measured

TWIN LAKES
INFLOW / OUTFLOW SAMPLING EVENT
6/12/2015

Analytes - Cations	Little Sandy Inflow 1	Little Sandy Inflow 2	Little Sandy Inflow 3	Little Sandy Middle	Sandy Middle	Twin Lakes Outflow	Culvert Inflow	Reporting Detection Limits	Reporting Units
Aluminum	**38.2**	**12.8**	<10.0	NM	NM	**12.4**	**32**	**10.0**	ug / L
Arsenic	<0.50	<0.50	<0.50	NM	NM	<0.50	**0.76**	**0.50**	ug / L
Barium	NM	NM	NM	NM	NM	NM	NM	**10.0**	ug / L
Calcium	**50.7**	**39.7**	**32.6**	**40.7**	**33.4**	**31.6**	**11.8**	**0.50**	mg / L
Iron	**582**	**259**	**106**	NM	NM	**350**	**2210**	**50.0**	ug / L
Magnesium	**69.3**	**57.7**	**49.9**	**57.7**	**47.2**	**43.6**	**4**	**0.50**	mg / L
Manganese	**126**	**97.9**	**24.8**	NM	NM	**61.8**	**139**	**10.0**	ug / L
Phosphorus	NM	NM	NM	NM	NM	NM	NM	**0.10**	mg / L
Potassium	**7.2**	**5.12**	**2.12**	NM	NM	**4.81**	**1.49**	**0.10**	mg / L
Rubidium	**2.9**	**3**	**2.4**	NM	NM	**2.8**	**1.2**	**1.0**	ug / L
Sodium	**28.1**	**19.2**	**12.6**	**20.2**	**17.9**	**16.8**	**3.8**	**0.50**	mg / L
Strontium	**175**	**128**	**102**	NM	NM	**107**	**45.1**	**10.0**	ug / L
Analytes - Anions	==========	==========	==========	==========	==========	==========	==========	==========	==========
Chloride	**42.8**	**28**	**13.7**	**31.4**	**28.5**	**27.4**	**8.5**	**5.0**	mg / l
Nitrogen, Kjeldahl, Total	**0.62**	**1.4**	**1.2**	**0.85**	**0.67**	**0.58**	**0.5**	**0.50**	mg / L
Ammonium as Nitrogen	<0.10	<0.10	**0.15**	<0.10	<0.10	<0.10	<0.10	**0.10**	mg / L
Sulfate	**271**	**205**	**169**	**219**	**174**	**163**	**2.1**	**10.0**	mg / L
Analytes - Other	==========	==========	==========	==========	==========	==========	==========	==========	==========
Total Dissolved Solids	**594**	**486**	**400**	**475**	**399**	**375**	**121**	**10.0**	mg / L
Total Suspended Solids	**1.6**	NM	NM	<1.2	<1.2	**1.6**	NM	**1.2**	mg / L
Alkalinity, Total as CaCO3	**137**	**115**	**115**	**116**	**93.7**	**91.1**	**36.7**	**5.0**	mg / L
Dissolved Organic Carbon	**14.8**	**16.5**	**19.9**	NM	NM	**14.8**	**12.4**	**1.0**	mg / L
Total Hardness by 2340B	**412**	**337**	**287**	**339**	**278**	**259**	**45.9**	**10.0**	mg / L
UV Absorbance @ 254 nm	**0.502**	**0.544**	**0.679**	NM	NM	**0.484**	**0.572**	**0.009**	cm^{-1}
SUVA	**3.4**	**3.3**	**3.4**	NM	NM	**3.3**	**4.6**	**0.1**	L / mg*m
YSI Data	==========	==========	==========	==========	==========	==========	==========	==========	==========
pH	**6.9**	**7.6**	**6.9**	**7.9**	**8.0**	**7.5**	**6.7**	**± 0.2**	Units
Temperature	**16.4**	**22.1**	**16.5**	**21.9**	**21.3**	**19.87**	**18.79**	**± 0.1**	°C
Specific Conductance	**892**	**707**	**583**	**730**	**610**	**590**	**106**	**± 1%**	uS / cm
Dissolved Oxygen	**3.4**	**8.5**	**5.1**	**9.1**	**8.98**	**7.68**	**8.23**	**± 0.01**	mg / L

Bold Print indicates the sample is above the detection limit
"<" indicates value below reporting limit
NM indicates that the analyte was not measured

TWIN LAKES
INFLOW / OUTFLOW SAMPLING EVENT
7/10/2015

Analytes - Cations	Little Sandy Inflow 1	Little Sandy Inflow 2	Little Sandy Inflow 3	Little Sandy Core	Little Sandy Middle	Sandy Middle	Twin Lakes Outflow	Culvert Inflow	Detection Limits	Reporting Reporting Units
Aluminum	**54.2**	<50.0	<50.0	NM	NM	<50.0	<50.0	<50.0	**50.0**	ug / L
Arsenic	NM	NM	NM	NM	NM	NM	NM	NM	**0.50**	ug / L
Barium	NM	NM	NM	NM	NM	NM	NM	NM	**10.0**	ug / L
Calcium	**60.9**	**39.3**	**44.3**	**47.5**	**47.7**	**38.4**	**35.3**	**15.4**	**0.50**	mg / L
Iron	**459**	**836**	**249**	NM	NM	**285**	**371**	**3150**	**50.0**	ug / L
Magnesium	**84.3**	**56.5**	**63.5**	**67.2**	**67.7**	**53.3**	**48.3**	**5.3**	**0.50**	mg / L
Manganese	**28.5**	**128**	**143**	NM	NM	**129**	**42.5**	**180**	**10.0**	ug / L
Phosphorus	NM	NM	NM	NM	NM	NM	NM	NM	**0.10**	mg / L
Potassium	**5.6**	**4.1**	**4.4**	NM	NM	**4.8**	**4.6**	**1.2**	**0.50**	mg / L
Rubidium	NM	NM	NM	NM	NM	NM	NM	NM	**1.0**	ug / L
Sodium	**39.3**	**20**	**22.3**	**25**	**25**	**20.8**	**19.1**	**4.4**	**0.50**	mg / L
Strontium	NM	NM	NM	NM	NM	NM	NM	NM	**10.0**	ug / L
Analytes - Anions	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========
Chloride	**45.9**	**23.6**	**29.1**	**33.2**	**32.6**	**29.3**	**25.7**	**9.8**	**2.0**	mg / l
Nitrogen, Kjeldahl, Total	**0.64**	**0.85**	**0.66**	**0.7**	**0.79**	**0.65**	**0.72**	**0.51**	**0.50**	mg / L
Ammonium as Nitrogen	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**0.10**	mg / L
Sulfate	**294**	**168**	**204**	**217**	**219**	**171**	**140**	<2.0	**4.0**	mg / L
Analytes - Other	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========
Total Dissolved Solids	**752**	**516**	**575**	**589**	**581**	**509**	**462**	**166**	**10.0**	mg / L
Total Suspended Solids	**1.6**	**3.5**	**1.6**	**2**	1.6	**2**	**1.6**	**3.2**	**1.0**	mg / L
Alkalinity, Total as CaCO3	**142**	**122**	**125**	**127**	**126**	**109**	**99.9**	**46.2**	**5.0**	mg / L
Dissolved Organic Carbon	**18.4**	**22**	**17.5**	NM	NM	**17**	**17.1**	**12.8**	**1.0**	mg / L
Total Hardness by 2340B	**499**	**331**	**372**	**395**	**398**	**315**	**287**	**60.6**	**3.3**	mg / L
UV Absorbance @ 254 nm	NM	NM	NM	NM	NM	NM	NM	NM	**0.009**	cm^{-1}
SUVA	NM	NM	NM	NM	NM	NM	NM	NM	**0.1**	L / mg*m
YSI Data	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========
pH	**7.5**	**7.6**	**7.8**	**8.1**	**8.2**	**8.1**	**8.1**	**7.1**	**± 0.2**	Units
Temperature	**19.7**	**21.6**	**21.6**	**22.7**	**22.3**	**22.7**	**23.1**	**14**	**± 0.1**	ºC
Specific Conductance	**969**	**703**	**719**	**644**	**765**	**644**	**581**	**129.6**	**± 1%**	uS / cm
Dissolved Oxygen	**8.2**	**8.2**	**10.1**	**9.1**	**10**	**9.1**	**9.7**	**7.96**	**± 0.01**	mg / L

Bold Print indicates the sample is above the detection limit
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NM indicates that the analyte was not measured

TWIN LAKES
INFLOW / OUTFLOW SAMPLING EVENT
8/21/2015

Analytes - Cations	Little Sandy Inflow 1	Little Sandy Inflow 2	Little Sandy Inflow 3	Little Sandy Middle	Sandy Middle	Twin Lakes Outflow	Culvert Inflow	Reporting Detection Limits	Reporting Units
Aluminum	**84.8**	**10.1**	<10.0	<10.0	**18.1**	**21.2**	**53**	**10.0**	ug / L
Arsenic	NM	NM	NM	NM	NM	NM	NM	**0.50**	ug / L
Barium	NM	NM	NM	NM	NM	NM	NM	**10.0**	ug / L
Calcium	**68.7**	**56.6**	**53.1**	**52.8**	**35.3**	**15.6**	**13.4**	**0.50**	mg / L
Iron	**1170**	**249**	**179**	**121**	**171**	**1200**	**3800**	**50.0**	ug / L
Magnesium	**94.3**	**82.3**	**79.8**	**80.8**	**54.6**	**14.3**	**4.8**	**0.50**	mg / L
Manganese	**193**	**77.8**	**91**	**98.7**	**40.1**	**53.9**	**210**	**10.0**	ug / L
Phosphorus	NM	NM	NM	NM	NM	NM	NM	**0.10**	mg / L
Potassium	**5.8**	**3.81**	**4.17**	**5.11**	**4.14**	**1.79**	**1.35**	**0.10**	mg / L
Rubidium	NM	NM	NM	NM	NM	NM	NM	**1.0**	ug / L
Sodium	**34.6**	**25.5**	**25.5**	**28.9**	**20.3**	**6.9**	**4.3**	**0.50**	mg / L
Strontium	NM	NM	NM	NM	NM	NM	NM	**10.0**	ug / L
Analytes - Anions	==========	==========	==========	==========	==========	==========	==========	==========	==========
Chloride	**51.3**	**34.2**	**33.9**	**40.4**	**28.8**	**12.1**	**11.2**	**5.0**	mg / l
Nitrogen, Kjeldahl, Total	**0.53**	**0.86**	**0.88**	**0.72**	**1.1**	**0.61**	**0.54**	**0.50**	mg / L
Ammonium as Nitrogen	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	**0.10**	mg / L
Sulfate	**366**	**276**	**250**	**260**	**162**	**33.8**	<2.0	**2.0**	mg / L
Analytes - Other	==========	==========	==========	==========	==========	==========	==========	==========	==========
Total Dissolved Solids	**799**	**652**	**623**	**622**	**436**	**174**	**124**	**10.0**	mg / L
Total Suspended Solids	<1.0	<1.0	**1.6**	**1.2**	**2**	<1.2	**5.2**	**1.0**	mg / L
Alkalinity, Total as CaCO3	**163**	**168**	**172**	**160**	**117**	**47.4**	**39.2**	**5.0**	mg / L
Dissolved Organic Carbon	**12.9**	**18.8**	**19.3**	**17**	**18.8**	**17.5**	**16.2**	**1.0**	mg / L
Total Hardness by 2340B	**560**	**480**	**461**	**465**	**313**	**97.9**	**53.3**	**10.0**	mg / L
UV Absorbance @ 254 nm	NM	NM	NM	NM	NM	NM	NM	**0.009**	cm^{-1}
SUVA	NM	NM	NM	NM	NM	NM	NM	**0.1**	L / mg*m
YSI Data	==========	==========	==========	==========	==========	==========	==========	==========	==========
pH	**7.7**	**7.8**	**8.1**	**8.4**	**8.2**	**7.0**	**7.1**	**± 0.2**	Units
Temperature	**13.9**	**14.3**	**15.7**	**16.7**	**15.8**	**14.6**	**13.6**	**± 0.1**	°C
Specific Conductance	**1074**	**976**	**866**	**890**	**632**	**219**	**119**	**± 1%**	uS / cm
Dissolved Oxygen	NM	NM	NM	NM	NM	NM	NM	**± 0.01**	mg / L

Bold Print indicates the sample is above the detection limit
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TWIN LAKES
INFLOW / OUTFLOW SAMPLING EVENT
9/25/2015

Analytes - Cations	Little Sandy Inflow 1	Little Sandy Inflow 2	Little Sandy Inflow 3	Little Sandy Middle	Sandy Middle	Twin Lakes Outflow	Culvert Inflow	Reporting Detection Limits	Reporting Units
Aluminum	**124**	**54.3**	**16.4**	NM	**14**	**35.8**	**39.4**	**10.0**	ug / L
Arsenic	NM	NM	NM	NM	NM	NM	NM	**0.50**	ug / L
Barium	NM	NM	NM	NM	NM	NM	NM	**10.0**	ug / L
Calcium	**75.7**	**27.9**	**30.5**	**52**	**41.1**	**35.2**	**12.2**	**0.50**	mg / L
Iron	**2030**	**4170**	**352**	NM	**301**	**811**	**2860**	**50.0**	ug / L
Magnesium	**104**	**38.2**	**46.5**	**75.3**	**61**	**50.1**	**4.4**	**0.50**	mg / L
Manganese	**309**	**67**	**31.5**	NM	**61.5**	**67.5**	**97.6**	**10.0**	ug / L
Phosphorus	NM	NM	NM	NM	NM	NM	NM	**0.10**	mg / L
Potassium	**8.86**	**1.78**	**1.55**	NM	**4.15**	**3.8**	**1760**	**0.10**	mg / L
Rubidium	NM	NM	NM	NM	NM	NM	NM	**1.0**	ug / L
Sodium	**42.2**	**13.7**	**11.1**	**27.6**	**23.6**	**20.3**	**4.4**	**0.50**	mg / L
Strontium	NM	NM	NM	NM	NM	NM	NM	**10.0**	ug / L
Analytes - Anions	==========	==========	==========	==========	==========	==========	==========	==========	==========
Chloride	**68.5**	**25.3**	**13.2**	**40.9**	**34.2**	**28.1**	**11.7**	**5.0**	mg / l
Nitrogen, Kjeldahl, Total	**0.98**	**1.6**	**1.2**	**1.1**	**0.95**	**1**	**0.83**	**0.50**	mg / L
Ammonium as Nitrogen	**0.1**	**0.17**	**0.12**	<0.10	<0.10	<0.10	<0.10	**0.10**	mg / L
Sulfate	**338**	**157**	**52.5**	**238**	**195**	**147**	<2.0	**10.0**	mg / L
Analytes - Other	==========	==========	==========	==========	==========	==========	==========	==========	==========
Total Dissolved Solids	**838**	**399**	**309**	**576**	**447**	**371**	**95**	**10.0**	mg / L
Total Suspended Solids	**3.6**	**2**	<1.0	<1.0	<1.0	**2.4**	**1.2**	**1.0**	mg / L
Alkalinity, Total as CaCO3	**202**	**128**	**201**	**177**	**134**	**115**	**39.2**	**5.0**	mg / L
Dissolved Organic Carbon	**17.6**	**28.5**	**30.7**	**20.1**	**20.3**	**19.3**	**16.3**	**1.0**	mg / L
Total Hardness by 2340B	**615**	**227**	**268**	**440**	**354**	**294**	**48.5**	**10.0**	mg / L
UV Absorbance @ 254 nm	NM	NM	NM	NM	NM	NM	NM	**0.009**	cm^{-1}
SUVA	NM	NM	NM	NM	NM	NM	NM	**0.1**	L / mg*m
YSI Data	==========	==========	==========	==========	==========	==========	==========	==========	==========
pH	**7.1**	**7.0**	**7.1**	**7.9**	**7.8**	**7.5**	**6.7**	**± 0.2**	Units
Temperature	**14.6**	**14.6**	**13.8**	**15.3**	**15.2**	**14.8**	**118**	**± 0.1**	°C
Specific Conductance	**1224**	**779**	**476**	**875**	**721**	**568**	**13.1**	**± 1%**	uS / cm
Dissolved Oxygen	NM	NM	NM	NM	NM	NM	NM	**± 0.01**	mg / L

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TWIN LAKES
INFLOW / OUTFLOW SAMPLING EVENT

10/19/2015

Analytes - Cations	Little Sandy Inflow 1	Little Sandy Inflow 2	Little Sandy Inflow 3	Little Sandy Middle	Sandy Middle	Twin Lakes Outflow	Culvert Inflow	Reporting Detection Limits	Reporting Units
Aluminum	**80.8**	<50.0	<50.0	NM	<50.0	<50.0	<50.0	**<50.0**	ug / L
Arsenic	NM	NM	NM	NM	NM	NM	NM	**0.50**	ug / L
Barium	NM	NM	NM	NM	NM	NM	NM	**10.0**	ug / L
Calcium	**91.7**	**68**	**45.4**	**59.1**	**47.4**	**42.2**	**10.8**	**0.50**	mg / L
Iron	**1130**	**218**	**448**	NM	**315**	**479**	**2400**	**50.0**	ug / L
Magnesium	**133**	**97**	**66.2**	**83.9**	**69.5**	**59.1**	**4**	**0.50**	mg / L
Manganese	**237**	**55.7**	**258**	NM	**42.2**	**54.4**	**133**	**10.0**	ug / L
Phosphorus	NM	NM	NM	NM	NM	NM	NM	**0.10**	mg / L
Potassium	**11.6**	**4.1**	**3.3**	NM	**4.7**	**4.3**	**1.6**	**0.10**	mg / L
Rubidium	NM	NM	NM	NM	NM	NM	NM	**1.0**	ug / L
Sodium	**52.4**	**30.6**	**21.1**	**31.3**	**26.5**	**23.2**	**4.7**	**0.50**	mg / L
Strontium	NM	NM	NM	NM	NM	NM	NM	**10.0**	ug / L
Analytes - Anions	==========	==========	==========	==========	==========	==========	==========	==========	==========
Chloride	**85.4**	**43.5**	**33.3**	**47.6**	**39.1**	**35.4**	**13.4**	**5.0**	mg / l
Nitrogen, Kjeldahl, Total	<0.50	**0.86**	**0.86**	**0.81**	**0.86**	**0.77**	**<0.50**	**0.50**	mg / L
Ammonium as Nitrogen	<0.10	<0.10	<0.10	<0.10	**0.15**	<0.10	<0.10	**0.10**	mg / L
Sulfate	**498**	**340**	**215**	**279**	**223**	**192**	**2.8**	**10.0**	mg / L
Analytes - Other	==========	==========	==========	==========	==========	==========	==========	==========	==========
Total Dissolved Solids	**1040**	**737**	**514**	**649**	**546**	**473**	**121**	**10.0**	mg / L
Total Suspended Solids	**2.4**	**1.2**	**2**	**3.2**	**4**	**4**	**3.5**	**1.0**	mg / L
Alkalinity, Total as CaCO3	**233**	**221**	**184**	**178**	**153**	**134**	**34.5**	**5.0**	mg / L
Dissolved Organic Carbon	**9.4**	**17.7**	**21**	**17.8**	**18.9**	**349**	**7.5**	**1.0**	mg / L
Total Hardness by 2340B	**776**	**569**	**386**	**493**	**405**	**17.5**	**43.3**	**10.0**	mg / L
UV Absorbance @ 254 nm	NM	NM	NM	NM	NM	NM	NM	**0.009**	cm^{-1}
SUVA	NM	NM	NM	NM	NM	NM	NM	**0.1**	L / mg*m
YSI Data	==========	==========	==========	==========	==========	==========	==========	==========	==========
pH	**7.4**	**7.1**	**8.1**	**8.4**	**8.1**	**8.1**	**7.1**	**± 0.2**	Units
Temperature	**6.9**	**6.3**	**7.3**	**7.3**	**6.6**	**6.4**	**7.3**	**± 0.1**	°C
Specific Conductance	**1435**	**1150**	**943**	**949**	**746**	**666**	**117**	**± 1%**	uS / cm
Dissolved Oxygen	NM	NM	NM	NM	NM	NM	NM	**± 0.01**	mg / L

Bold Print indicates the sample is above the detection limit
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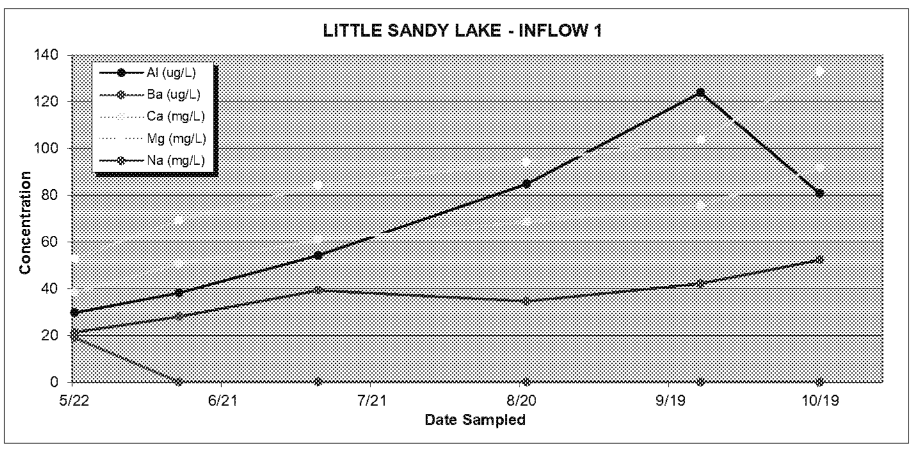
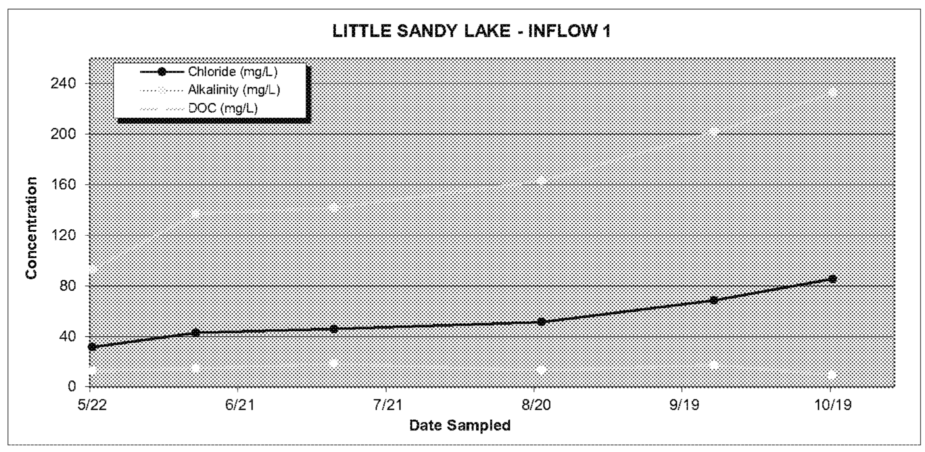
NM indicates that the analyte was not measured

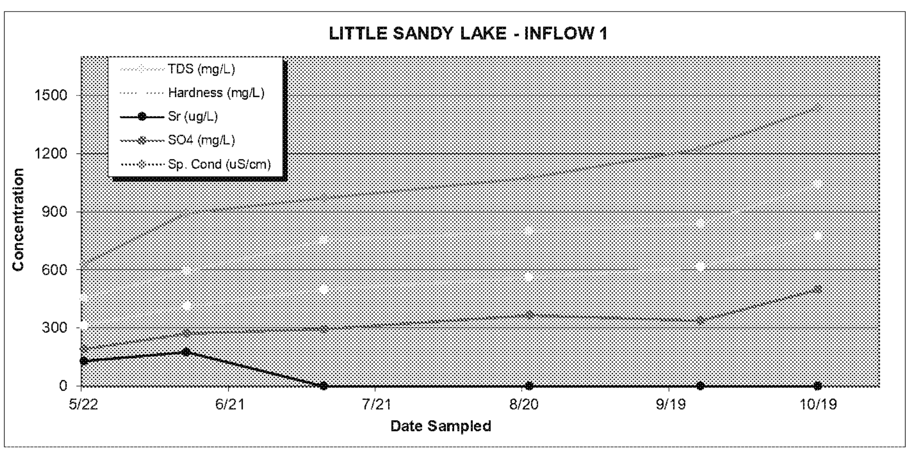
LITTLE SANDY LAKE - INFLOW 1

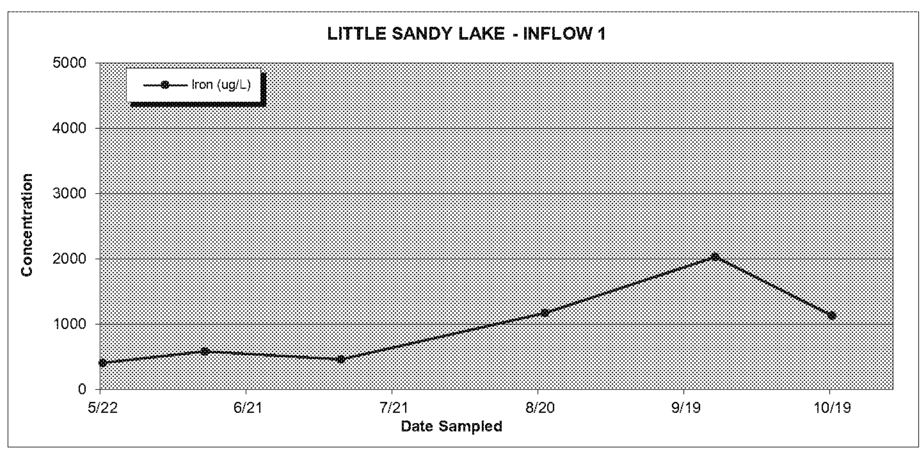
Analytes - Cations	5/22/2015 Little Sandy Inflow 1	6/12/2015 Little Sandy Inflow 1	7/10/2015 Little Sandy Inflow 1	8/21/2015 Little Sandy Inflow 1	9/25/2015 Little Sandy Inflow 1	10/19/2015 Little Sandy Inflow 1	Reporting Units
Aluminum	**29.7**	**38.2**	**54.2**	**84.8**	**124**	**80.8**	µg / L
Arsenic	<0.50	<0.50	NM	NM	NM	NM	µg / L
Barium	**19**	NM	NM	NM	NM	NM	µg / L
Calcium	**38.4**	**50.7**	**60.9**	**68.7**	**75.7**	**91.7**	mg / L
Iron	**407**	**582**	**459**	**1170**	**2030**	**1130**	µg / L
Magnesium	**53**	**69.3**	**84.3**	**94.3**	**104**	**133**	mg / L
Manganese	**31.3**	**126**	**28.5**	**193**	**309**	**237**	µg / L
Phosphorus	<0.10	NM	NM	NM	NM	NM	mg / L
Potassium	**6.27**	**7.2**	**5.6**	**5.8**	**8.86**	**11.6**	mg / L
Rubidium	**2.8**	**2.9**	NM	NM	NM	NM	µg / L
Sodium	**21.3**	**28.1**	**39.3**	**34.6**	**42.2**	**52.4**	mg / L
Strontium	**129**	**175**	NM	NM	NM	NM	µg / L
Analytes - Anions	==========	==========	==========	==========	==========	==========	==========
Chloride	**31.4**	**42.8**	**45.9**	**51.3**	**68.5**	**85.4**	mg / L
Nitrogen, Kjeldahl, Total	**0.62**	**0.62**	**0.64**	**0.53**	**0.98**	<0.50	mg / L
Ammonium as Nitrogen	NM	<0.10	<0.10	<0.10	**0.10**	<0.10	mg / L
Sulfate	**191**	**271**	**294**	**366**	**338**	**498**	mg / L
Analytes - Other	==========	==========	==========	==========	==========	==========	==========
Total Dissolved Solids	**457**	**594**	**752**	**799**	**838**	**1040**	mg / L
Total Suspended Solids	NM	**1.6**	**1.6**	<1.0	**3.6**	**2.4**	mg / L
Alkalinity, Total as CaCO3	**93.1**	**137**	**142**	**163**	**202**	**233**	mg / L
Dissolved Organic Carbon	**12.5**	**14.8**	**18.4**	**12.9**	**17.6**	**9.4**	mg / L
Total Hardness by 2340B	**314**	**412**	**499**	**560**	**615**	**776**	mg / L
UV Absorbance @ 254 nm	**0.429**	**0.502**	NM	NM	NM	NM	cm^{-1}
SUVA	**3.5**	**3.4**	NM	NM	NM	NM	L / mg*m
YSI Probe Plus Data	==========	==========	==========	==========	==========	==========	==========
pH	**7.14**	**6.9**	**7.5**	**7.7**	**7.05**	**7.4**	Units
Temperature	**9.8**	**16.4**	**19.7**	**13.9**	**14.6**	**6.9**	°C
Specific Conductance	**632**	**892**	**969.0**	**1074**	**1224**	**1435**	uS / cm
Dissolved Oxygen	NM	**3.4**	**8.2**	NM	NM	NM	mg / L

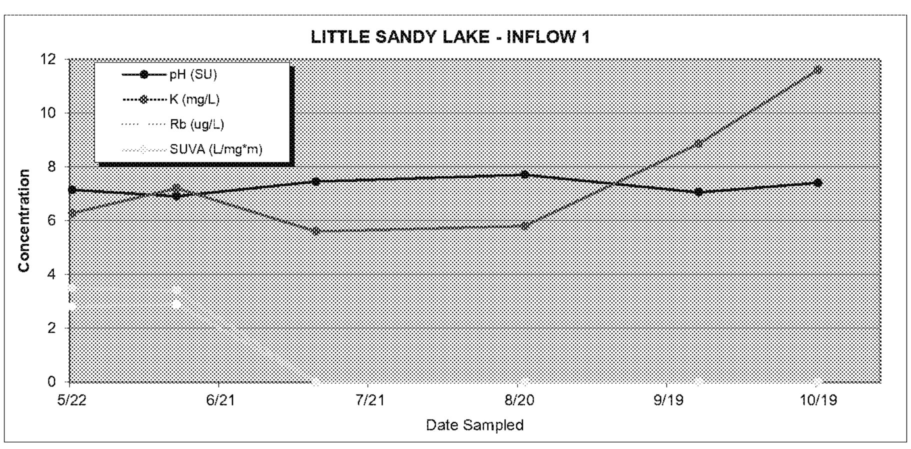
Bold Print indicates the sample is above the detection limit
NM indicates that the analyte was not measured
"<" indicates value below reporting limit
For a list of reporting detection limits, see data tables organized by sample date

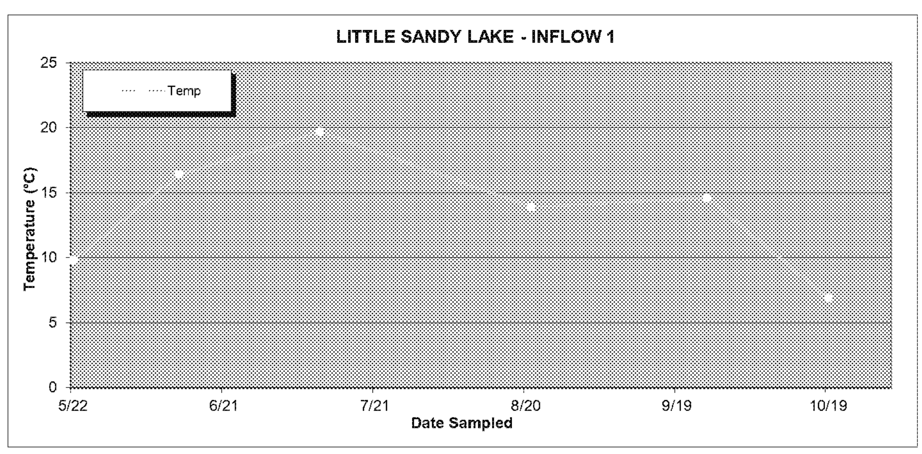












LITTLE SANDY LAKE - INFLOW 2

Analytes - Cations	5/22/2015 Little Sandy Inflow 2	6/12/2015 Little Sandy Inflow 2	7/10/2015 Little Sandy Inflow 2	8/21/2015 Little Sandy Inflow 2	9/25/2015 Little Sandy Inflow 2	10/19/2015 Little Sandy Inflow 2	Reporting Units
Aluminum	**15.2**	**12.8**	<50.0	**10.1**	**54.3**	<50.0	µg / L
Arsenic	<0.50	<0.50	NM	NM	NM	NM	µg / L
Barium	**23.7**	NM	NM	NM	NM	NM	µg / L
Calcium	**42.6**	**39.7**	**39.3**	**56.6**	**27.9**	**68**	mg / L
Iron	**238**	**259**	**836**	**249**	**4170**	**218**	µg / L
Magnesium	**62.6**	**57.7**	**56.5**	**82.3**	**38.2**	**97**	mg / L
Manganese	**32.8**	**97.9**	**128**	**77.8**	**67**	**55.7**	µg / L
Phosphorus	<0.10	NM	NM	NM	NM	NM	mg / L
Potassium	**5.73**	**5.12**	**4.1**	**3.81**	**1.78**	**4.1**	mg / L
Rubidium	**3**	**3**	NM	NM	NM	NM	µg / L
Sodium	**20.8**	**19.2**	**20**	**25.5**	**13.7**	**30.6**	mg / L
Strontium	**133**	**128**	NM	NM	NM	NM	µg / L
Analytes - Anions	==========	==========	==========	==========	==========	==========	==========
Chloride	**29.6**	**28**	**23.6**	**34.2**	**25.3**	**43.5**	mg / L
Nitrogen, Kjeldahl, Total	**0.73**	**1.4**	**0.85**	**0.86**	**1.6**	**0.86**	mg / L
Ammonium as Nitrogen	NM	<0.10	<0.10	<0.10	**0.17**	<0.10	mg / L
Sulfate	**216**	**205**	**168**	**276**	**157**	**340**	mg / L
Analytes - Other	==========	==========	==========	==========	==========	==========	==========
Total Dissolved Solids	**506**	**486**	**516**	**652**	**399**	**737**	mg / L
Total Suspended Solids	NM	NM	**3.5**	<1.0	**2**	**1.2**	mg / L
Alkalinity, Total as CaCO3	**105**	**115**	**122**	**168**	**128**	**221**	mg / L
Dissolved Organic Carbon	**12.9**	**16.5**	**22**	**18.8**	**28.5**	**17.7**	mg / L
Total Hardness by 2340B	**364**	**337**	**331**	**480**	**227**	**569**	mg / L
UV Absorbance @ 254 nm	**0.408**	**0.544**	NM	NM	NM	NM	cm^{-1}
SUVA	**3.3**	**3.3**	NM	NM	NM	NM	L / mg*m
YSI Probe Plus Data	==========	==========	==========	==========	==========	==========	==========
pH	**7.68**	**7.6**	**7.6**	**7.8**	**7.02**	**7.1**	Units
Temperature	**14.2**	**22.1**	**21.6**	**14.3**	**14.6**	**6.3**	°C
Specific Conductance	**735**	**707**	**703.0**	**976**	**779**	**1150**	uS / cm
Dissolved Oxygen	NM	**8.5**	**8.2**	NM	NM	NM	mg / L

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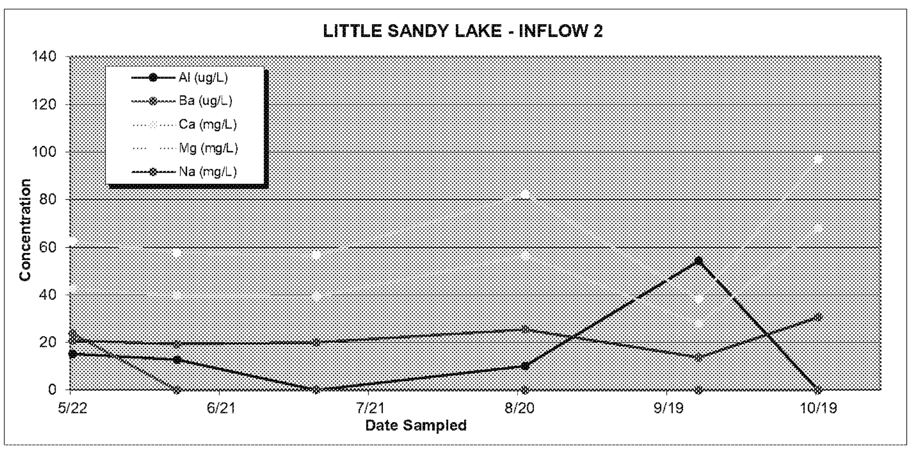
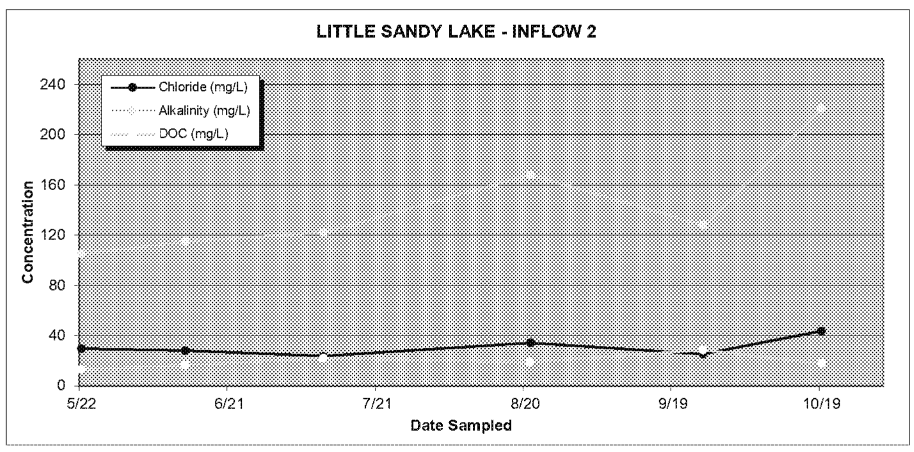
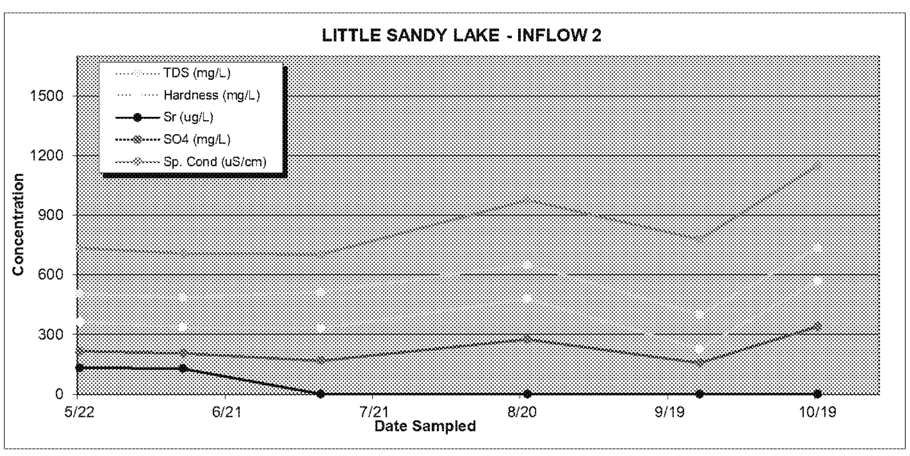
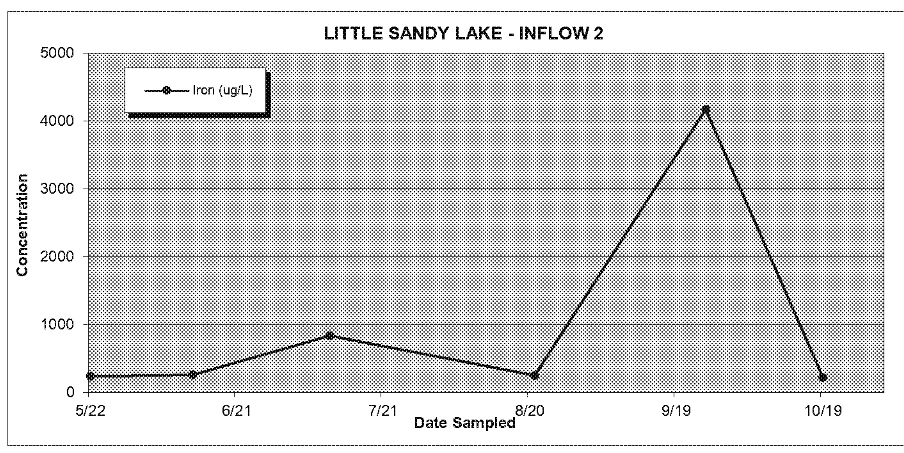
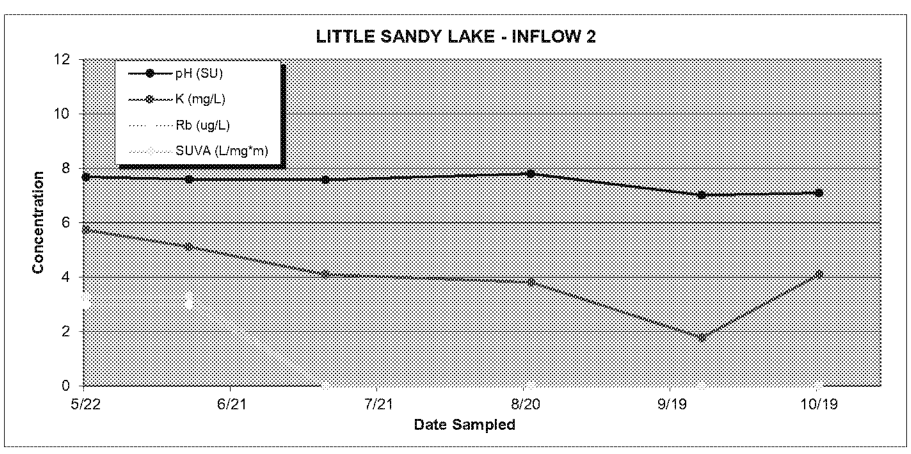
For a list of reporting detection limits, see data tables organized by sample date

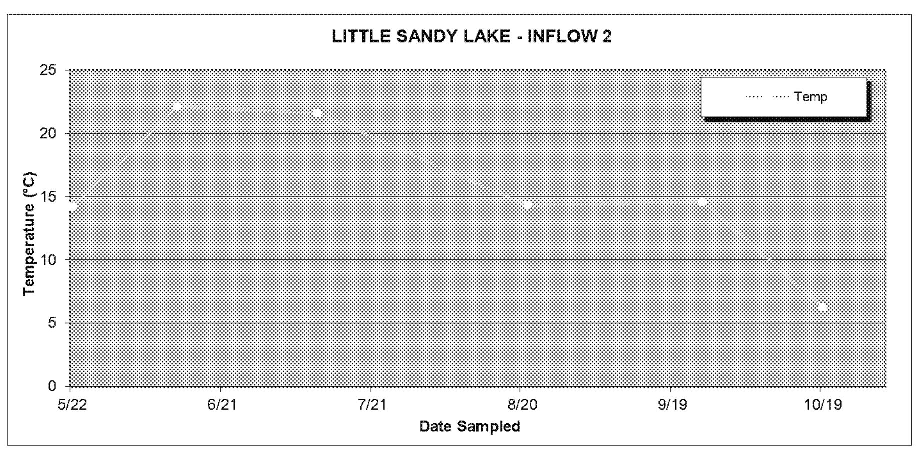












LITTLE SANDY LAKE - INFLOW 3

Analytes - Cations	5/22/2015 Little Sandy Inflow 3	6/12/2015 Little Sandy Inflow 3	7/10/2015 Little Sandy Inflow 3	8/21/2015 Little Sandy Inflow 3	9/25/2015 Little Sandy Inflow 3	10/19/2015 Little Sandy Inflow 3	Reporting Units
Aluminum	<10.0	<10.0	<50.0	<10.0	**16.4**	<50.0	µg / L
Arsenic	<0.50	<0.50	NM	NM	NM	NM	µg / L
Barium	**26.5**	NM	NM	NM	NM	NM	µg / L
Calcium	**34**	**32.6**	**44.3**	**53.1**	**30.5**	**45.4**	mg / L
Iron	**80**	**106**	**249**	**179**	**352**	**448**	µg / L
Magnesium	**55.3**	**49.9**	**63.5**	**79.8**	**46.5**	**66.2**	mg / L
Manganese	**14.8**	**24.8**	**143**	**91**	**31.5**	**258**	µg / L
Phosphorus	<0.10	NM	NM	NM	NM	NM	mg / L
Potassium	**3.38**	**2.12**	**4.4**	**4.17**	**1.55**	**3.3**	mg / L
Rubidium	**2.6**	**2.4**	NM	NM	NM	NM	µg / L
Sodium	**13.9**	**12.6**	**22.3**	**25.5**	**11.1**	**21.1**	mg / L
Strontium	**101**	**102**	NM	NM	NM	NM	µg / L
Analytes - Anions	==========	==========	==========	==========	==========	==========	==========
Chloride	**15.8**	**13.7**	**29.1**	**33.9**	**13.2**	**33.3**	mg / L
Nitrogen, Kjeldahl, Total	**0.59**	**1.2**	**0.66**	**0.88**	**1.2**	**0.86**	mg / L
Ammonium as Nitrogen	NM	**0.15**	<0.10	<0.10	**0.12**	<0.10	mg / L
Sulfate	**182**	**169**	**204**	**250**	**52.5**	**215**	mg / L
Analytes - Other	==========	==========	==========	==========	==========	==========	==========
Total Dissolved Solids	**418**	**400**	**575**	**623**	**309**	**514**	mg / L
Total Suspended Solids	NM	NM	**1.6**	**1.6**	<1.0	**2**	mg / L
Alkalinity, Total as CaCO3	**92.6**	**115**	**125**	**172**	**201**	**184**	mg / L
Dissolved Organic Carbon	**14.7**	**19.9**	**17.5**	**19.3**	**30.7**	**21**	mg / L
Total Hardness by 2340B	**313**	**287**	**372**	**461**	**268**	**386**	mg / L
UV Absorbance @ 254 nm	**0.468**	**0.679**	NM	NM	NM	NM	cm^{-1}
SUVA	**3.3**	**3.4**	NM	NM	NM	NM	L / mg*m
YSI Probe Plus Data	==========	==========	==========	==========	==========	==========	==========
pH	**7.31**	**6.85**	**7.75**	**8.1**	**7.06**	**8.1**	Units
Temperature	**8.5**	**16.5**	**21.60**	**15.7**	**13.8**	**7.3**	°C
Specific Conductance	**601**	**583**	**719.00**	**866**	**476**	**943**	uS / cm
Dissolved Oxygen	NM	**5.1**	**10.10**	NM	NM	NM	mg / L

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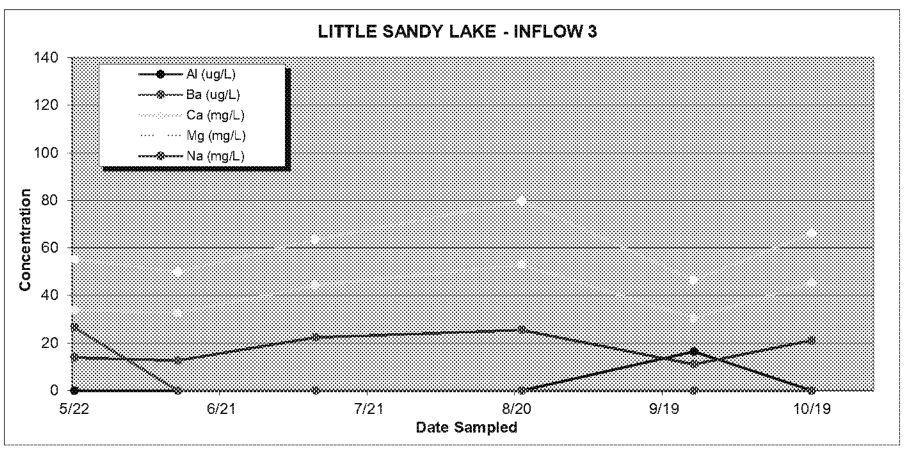

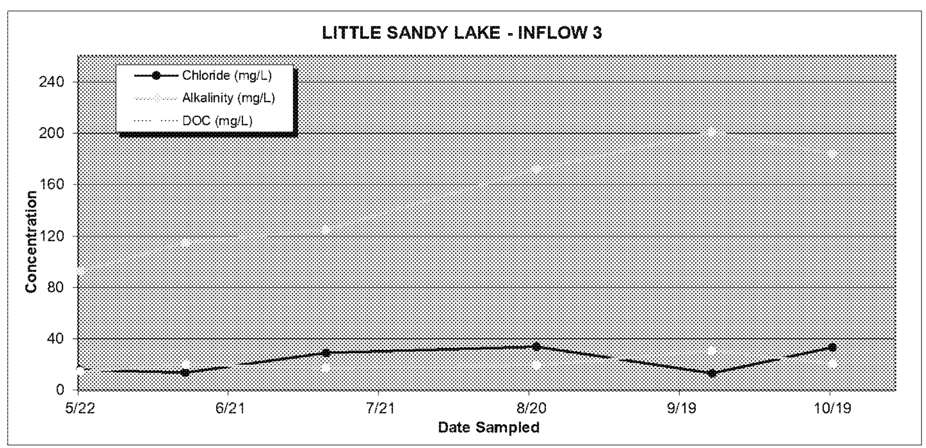

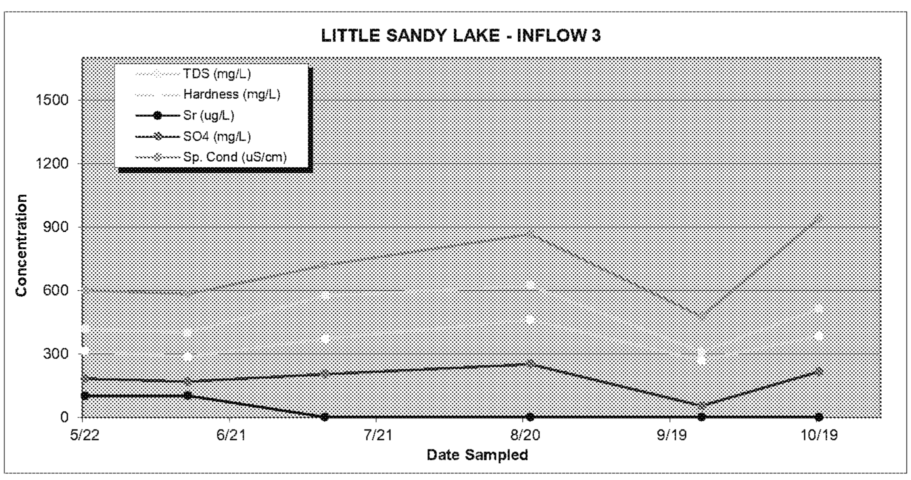

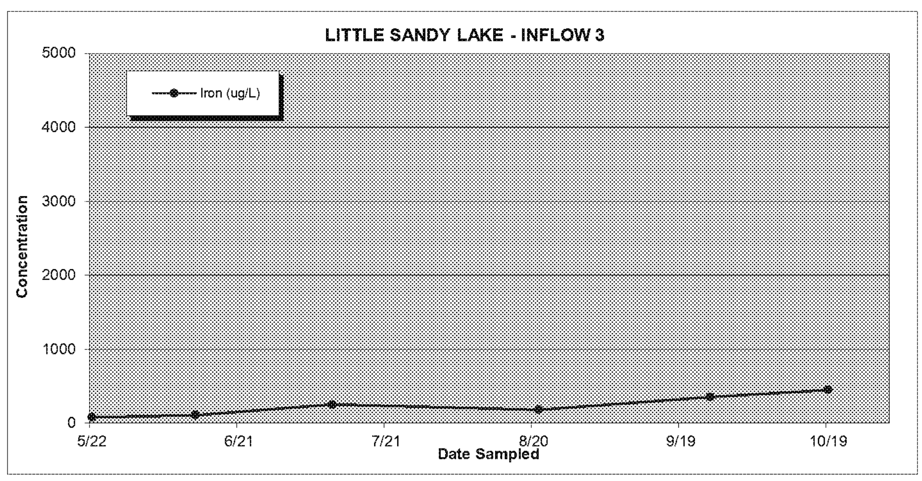

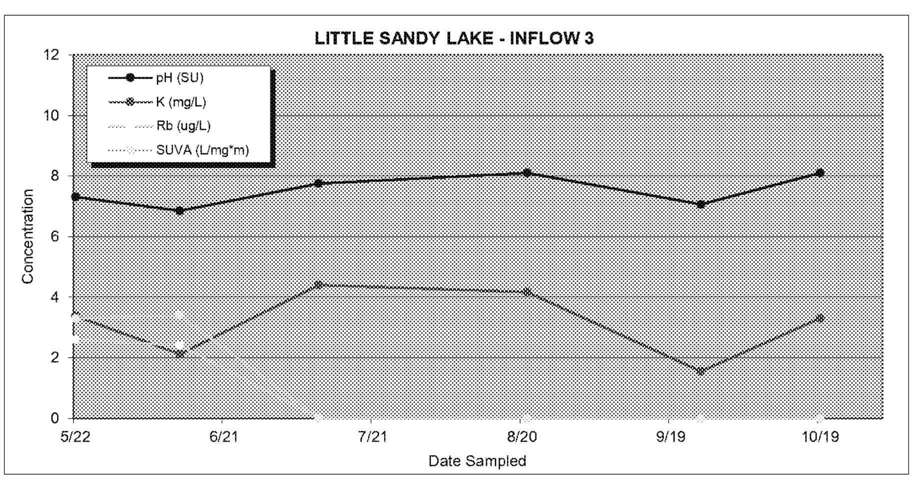

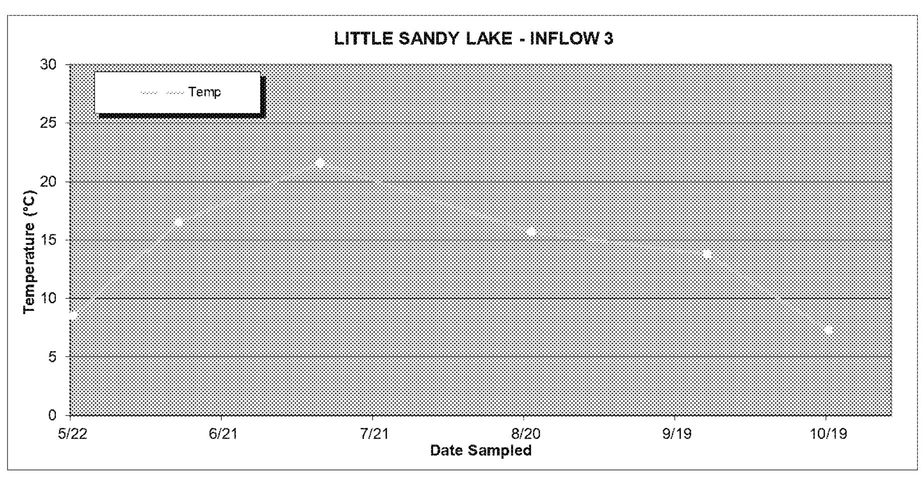

LITTLE SANDY LAKE - MIDDLE

Analytes - Cations	5/22/2015 Little Sandy Middle	6/12/2015 Little Sandy Middle	7/10/2015 Little Sandy Middle	8/21/2015 Little Sandy Middle	9/25/2015 Little Sandy Middle	10/19/2015 Little Sandy Middle	Reporting Units
Aluminum	NM	NM	NM	<10.0	NM	NM	µg / L
Arsenic	NM	NM	NM	NM	NM	NM	µg / L
Barium	NM	NM	NM	NM	NM	NM	µg / L
Calcium	**45.2**	**40.7**	**47.7**	**52.8**	**52**	**59.1**	mg / L
Iron	NM	NM	NM	**121**	NM	NM	µg / L
Magnesium	**64.9**	**57.7**	**67.7**	**80.8**	**75.3**	**83.9**	mg / L
Manganese	NM	NM	NM	**98.7**	NM	NM	µg / L
Phosphorus	NM	NM	NM	NM	NM	NM	mg / L
Potassium	NM	NM	NM	**5.11**	NM	NM	mg / L
Rubidium	NM	NM	NM	NM	NM	NM	µg / L
Sodium	**23**	**20.2**	**25**	**28.9**	**27.6**	**31.3**	mg / L
Strontium	NM	NM	NM	NM	NM	NM	µg / L
Analytes - Anions	==========	==========	==========	==========	==========	==========	==========
Chloride	**33.9**	**31.4**	**32.6**	**40.4**	**40.9**	**47.6**	mg / L
Nitrogen, Kjeldahl, Total	NM	**0.85**	**0.79**	**0.72**	**1.1**	**0.81**	mg / L
Ammonium as Nitrogen	NM	<0.10	<0.10	<0.10	<0.10	<0.10	mg / L
Sulfate	**223**	**219**	**219**	**260**	**238**	**279**	mg / L
Analytes - Other	==========	==========	==========	==========	==========	==========	==========
Total Dissolved Solids	**530**	**475**	**581**	**622**	**576**	**649**	mg / L
Total Suspended Solids	NM	<1.2	**1.6**	**1.2**	<1.0	**3.2**	mg / L
Alkalinity, Total as CaCO3	**110**	**116**	**126**	**160**	**177**	**178**	mg / L
Dissolved Organic Carbon	NM	NM	NM	**17**	**20.1**	**17.8**	mg / L
Total Hardness by 2340B	**380**	**339**	**398**	**465**	**440**	**493**	mg / L
UV Absorbance @ 254 nm	NM	NM	NM	NM	NM	NM	cm^{-1}
SUVA	NM	NM	NM	NM	NM	NM	L / mg*m
YSI Probe Plus Data	==========	==========	==========	==========	==========	==========	==========
pH	**8.13**	**7.9**	**8.2**	**8.4**	**7.89**	**8.4**	Units
Temperature	**15**	**21.9**	**22.3**	**16.7**	**15.3**	**7.3**	°C
Specific Conductance	**775**	**730**	**765**	**890**	**875**	**949**	uS / cm
Dissolved Oxygen	NM	**9.1**	**10**	NM	NM	NM	mg / L

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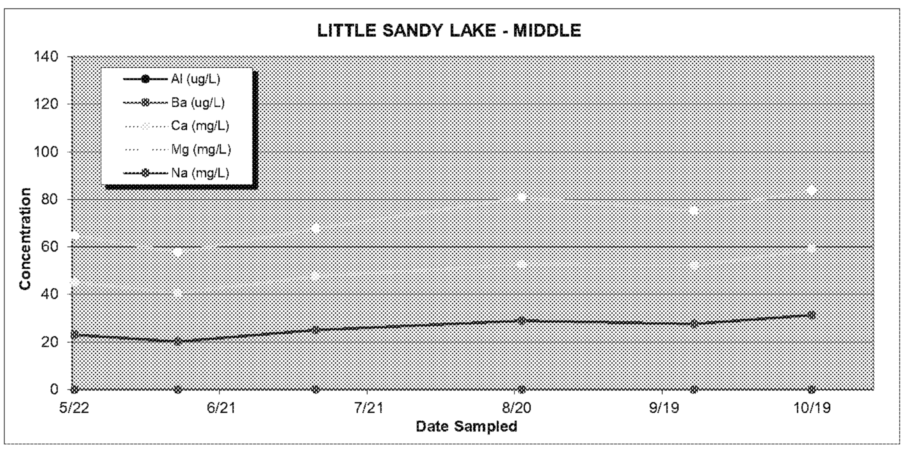

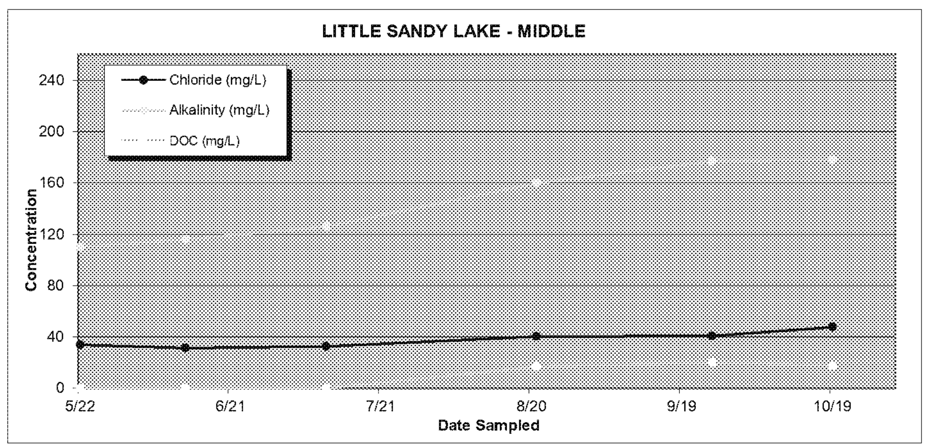

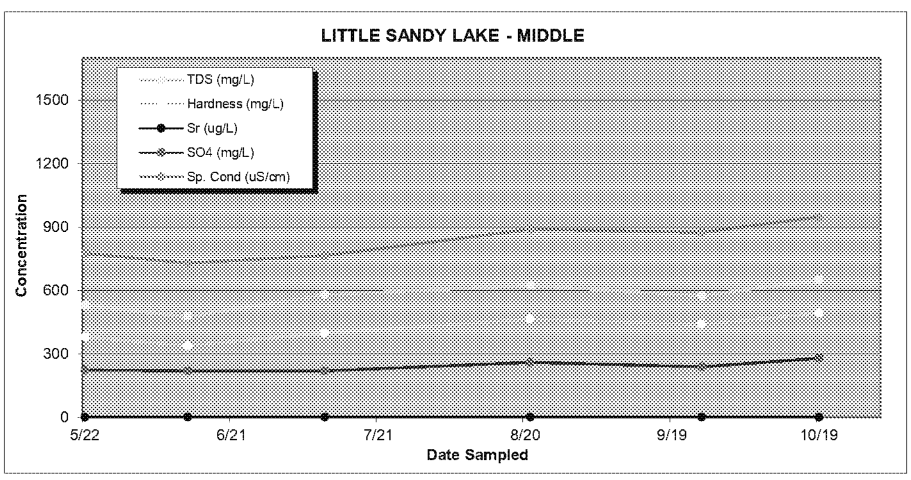

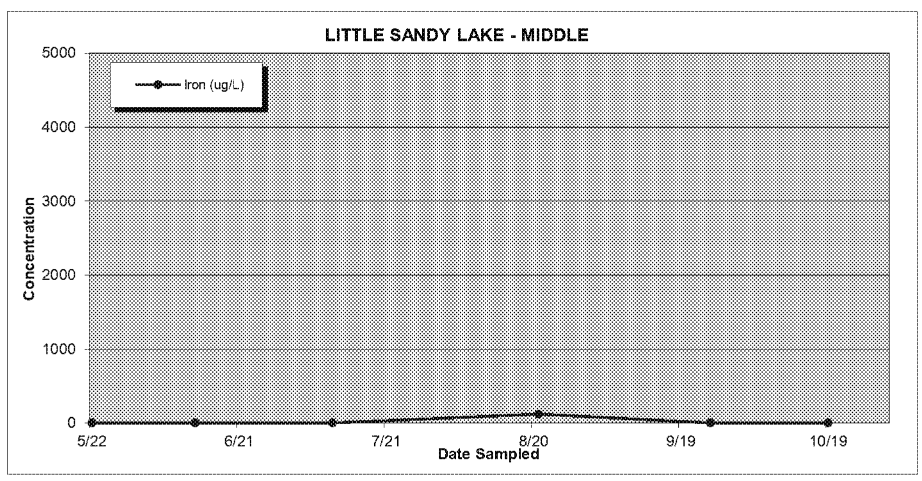

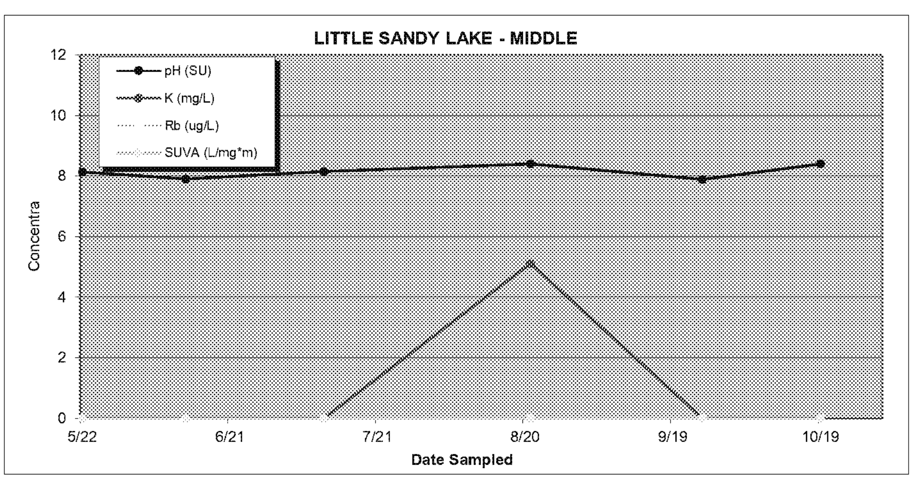

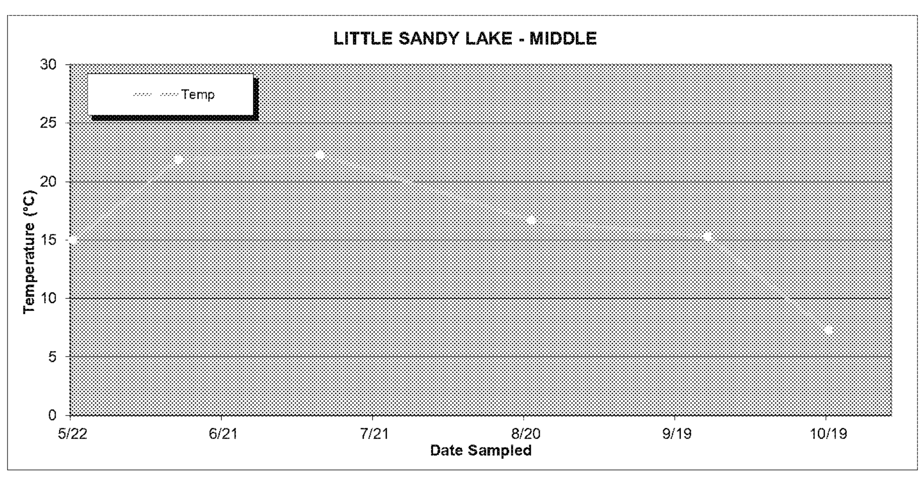

SANDY LAKE - MIDDLE

Analytes - Cations	5/22/2015 Sandy Middle	6/12/2015 Sandy Middle	7/10/2015 Sandy Middle	8/21/2015 Sandy Middle	9/25/2015 Sandy Middle	10/19/2015 Sandy Middle	Reporting Units
Aluminum	NM	NM	<50.0	**18.1**	**14**	**<50.0**	µg / L
Arsenic	NM	NM	NM	NM	NM	NM	µg / L
Barium	NM	NM	NM	NM	NM	NM	µg / L
Calcium	**40.7**	**33.4**	**38.4**	**35.3**	**41.1**	**47.4**	mg / L
Iron	NM	NM	**285**	**171**	**301**	**315**	µg / L
Magnesium	**57.4**	**47.2**	**53.3**	**54.6**	**61**	**69.5**	mg / L
Manganese	NM	NM	**129**	**40.1**	**61.5**	**42.2**	µg / L
Phosphorus	NM	NM	NM	NM	NM	NM	mg / L
Potassium	NM	NM	**4.8**	**4.14**	**4.15**	**4.7**	mg / L
Rubidium	NM	NM	NM	NM	NM	NM	µg / L
Sodium	**22.2**	**17.9**	**20.8**	**20.3**	**23.6**	**26.5**	mg / L
Strontium	NM	NM	NM	NM	NM	NM	µg / L
Analytes - Anions	==========	==========	==========	==========	==========	==========	==========
Chloride	**33.4**	**28.5**	**29.3**	**28.8**	**34.2**	**39.1**	mg / L
Nitrogen, Kjeldahl, Total	NM	**0.67**	**0.65**	**1.1**	**0.95**	**0.86**	mg / L
Ammonium as Nitrogen	NM	<0.10	<0.10	<0.10	<0.10	**0.15**	mg / L
Sulfate	**196**	**174**	**171**	**162**	**195**	**223**	mg / L
Analytes - Other	==========	==========	==========	==========	==========	==========	==========
Total Dissolved Solids	**466**	**399**	**509**	**436**	**447**	**546**	mg / L
Total Suspended Solids	NM	<1.2	**2**	**2**	<1.0	**4**	mg / L
Alkalinity, Total as CaCO3	**96.1**	**93.7**	**109**	**117**	**134**	**153**	mg / L
Dissolved Organic Carbon	NM	NM	**17**	**18.8**	**20.3**	**18.9**	mg / L
Total Hardness by 2340B	**338**	**278**	**315**	**313**	**354**	**405**	mg / L
UV Absorbance @ 254 nm	NM	NM	NM	NM	NM	NM	cm^{-1}
SUVA	NM	NM	NM	NM	NM	NM	L / mg*m
YSI Probe Plus Data	==========	==========	==========	==========	==========	==========	==========
pH	**8**	**8.04**	**8.05**	**8.2**	**7.79**	**8.1**	Units
Temperature	**14.9**	**21.3**	**22.70**	**15.8**	**15.2**	**6.6**	°C
Specific Conductance	**668**	**610**	**644**	**632**	**721**	**746**	uS / cm
Dissolved Oxygen	NM	**8.98**	**9.10**	NM	NM	NM	mg / L

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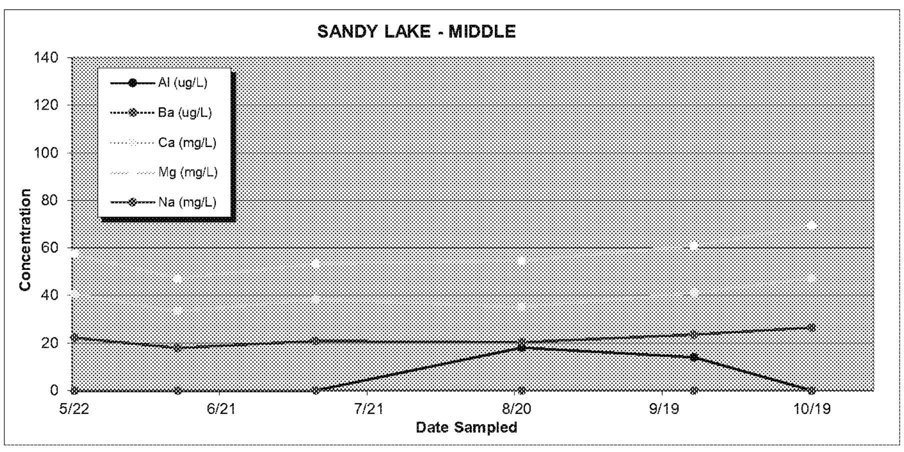

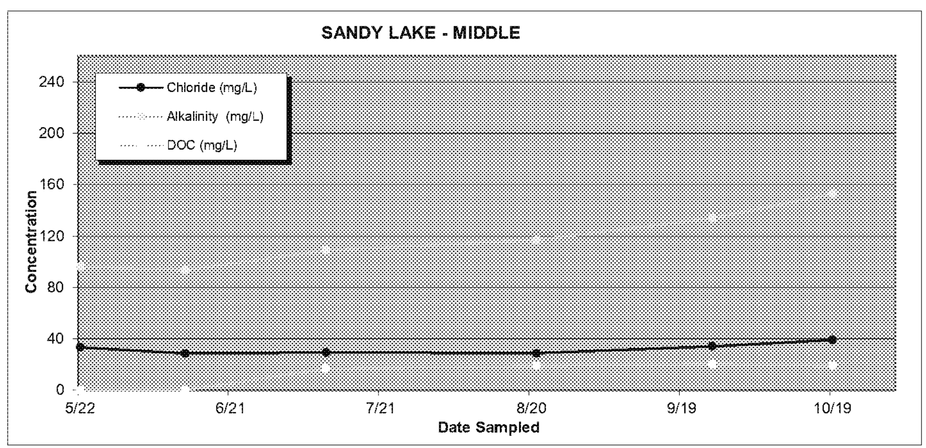

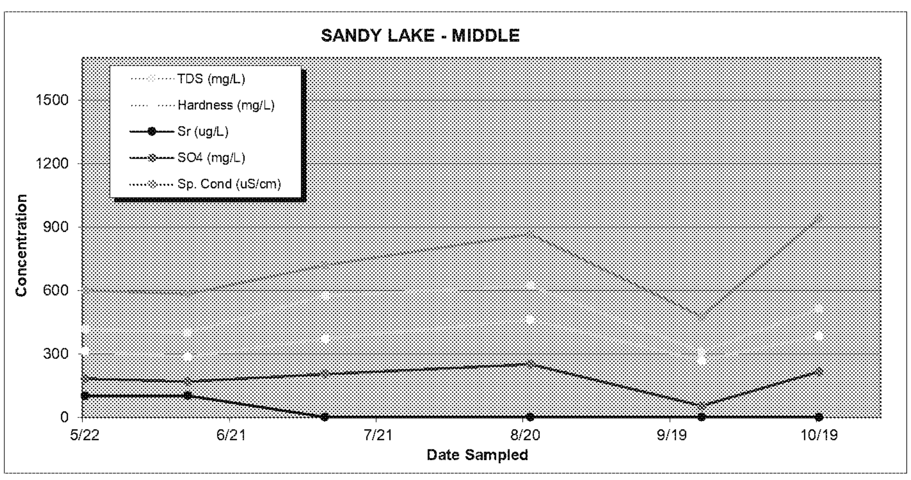

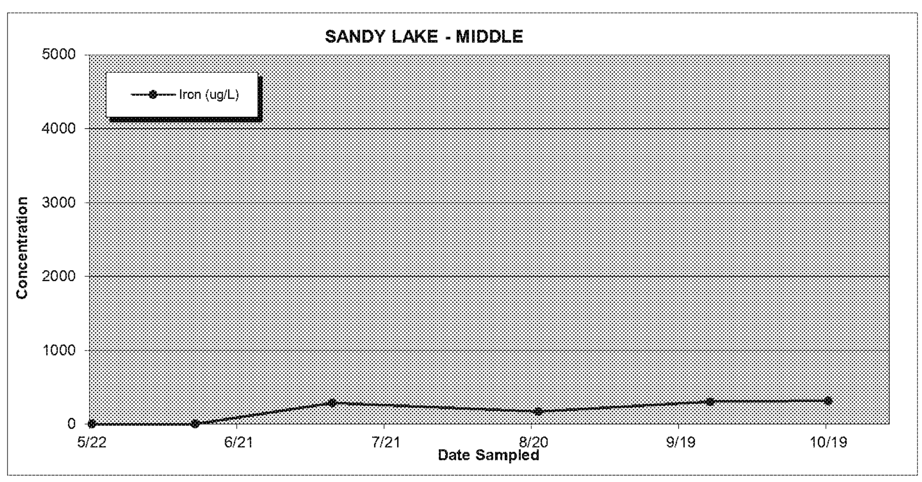

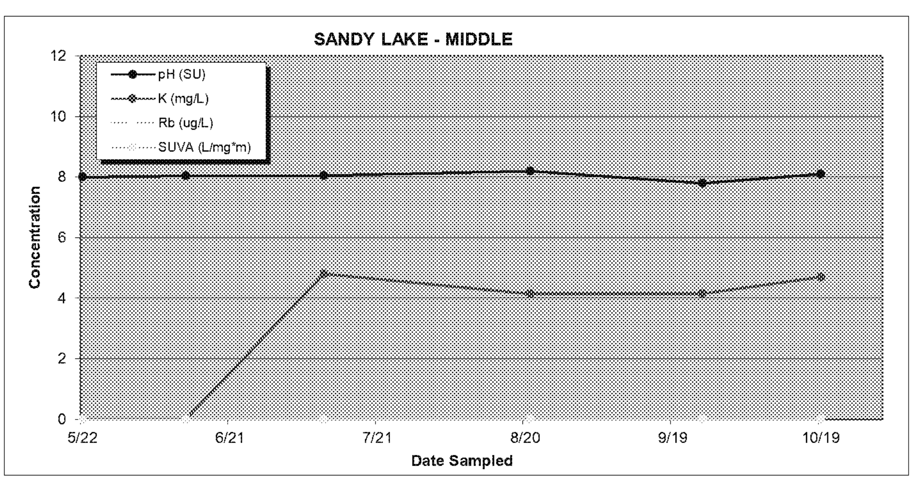

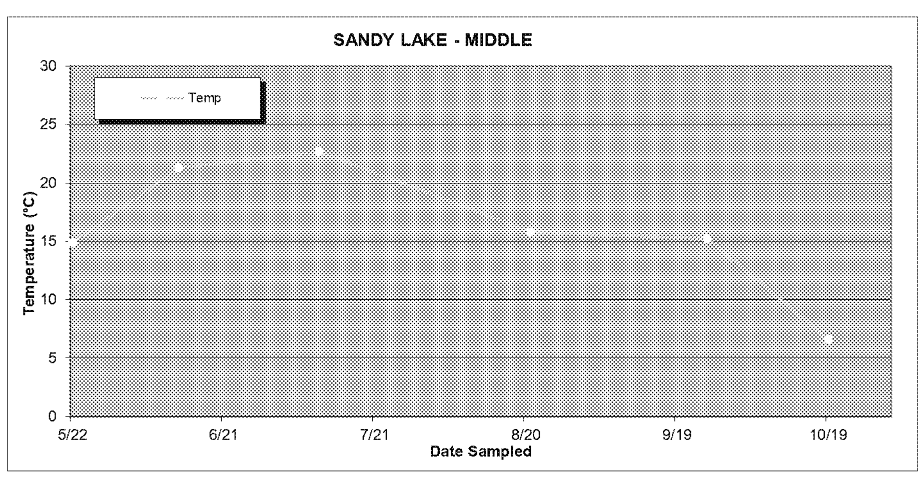

CULVERT INFLOW

Analytes - Cations	5/22/2015 Culvert Inflow	6/12/2015 Culvert Inflow	7/10/2015 Culvert Inflow	8/21/2015 Culvert Inflow	9/25/2015 Culvert Inflow	10/19/2015 Culvert Inflow	Reporting Units
Aluminum	**28.4**	**32**	<50.0	**53**	**39.4**	<50.0	μg / L
Arsenic	<0.50	**0.76**	NM	NM	NM	NM	μg / L
Barium	**17.5**	NM	NM	NM	NM	NM	μg / L
Calcium	**9**	**11.8**	**15.4**	**13.4**	**12.2**	**10.8**	mg / L
Iron	**1180**	**2210**	**3150**	**3800**	**2860**	**2400**	μg / L
Magnesium	**3.2**	**4**	**5.3**	**4.8**	**4.4**	**4**	mg / L
Manganese	**46.1**	**139**	**180**	**210**	**97.6**	**133**	μg / L
Phosphorus	<0.10	NM	NM	NM	NM	NM	mg / L
Potassium	**1.88**	**1.49**	**1.2**	**1.35**	**1.76**	**1.6**	mg / L
Rubidium	**1.4**	**1.2**	NM	NM	NM	NM	μg / L
Sodium	**3.7**	**3.8**	**4.4**	**4.3**	**4.4**	**4.7**	mg / L
Strontium	**34.3**	**45.1**	NM	NM	NM	NM	μg / L
Analytes - Anions	==========	==========	==========	==========	==========	==========	==========
Chloride	**8.2**	**8.5**	**9.8**	**11.2**	**11.7**	**13.4**	mg / L
Nitrogen, Kjeldahl, Total	<0.50	**0.5**	**0.51**	**0.54**	**0.83**	<0.50	mg / L
Ammonium as Nitrogen	NM	<0.10	<0.10	<0.10	<0.10	<0.10	mg / L
Sulfate	**2.5**	**2.1**	<2.0	<2.0	<2.0	**2.8**	mg / L
Analytes - Other	==========	==========	==========	==========	==========	==========	==========
Total Dissolved Solids	**97**	**121**	**166**	**124**	**95**	**121**	mg / L
Total Suspended Solids	NM	NM	**3.2**	**5.2**	**1.2**	**3.5**	mg / L
Alkalinity, Total as CaCO3	**24.6**	**36.7**	**46.2**	**39.2**	**39.2**	**34.5**	mg / L
Dissolved Organic Carbon	**11.3**	**12.4**	**12.8**	**16.2**	**16.3**	**7.5**	mg / L
Total Hardness by 2340B	**35.7**	**45.9**	**60.6**	**53.3**	**48.5**	**43.3**	mg / L
UV Absorbance @ 254 nm	**0.478**	**0.572**	NM	NM	NM	NM	cm^{-1}
SUVA	**4.4**	**4.6**	NM	NM	NM	NM	L / mg*m
YSI Probe Plus Data	==========	==========	==========	==========	==========	==========	==========
pH	**6.74**	**6.73**	**7.1**	**7.1**	**6.65**	**7.1**	Units
Temperature	**14.5**	**18.79**	**14**	**13.6**	**13.1**	**7.3**	^{o}C
Specific Conductance	**85**	**106**	**129.6**	**119**	**118**	**117**	uS / cm
Dissolved Oxygen	NM	**8.23**	**7.96**	NM	NM	NM	mg / L

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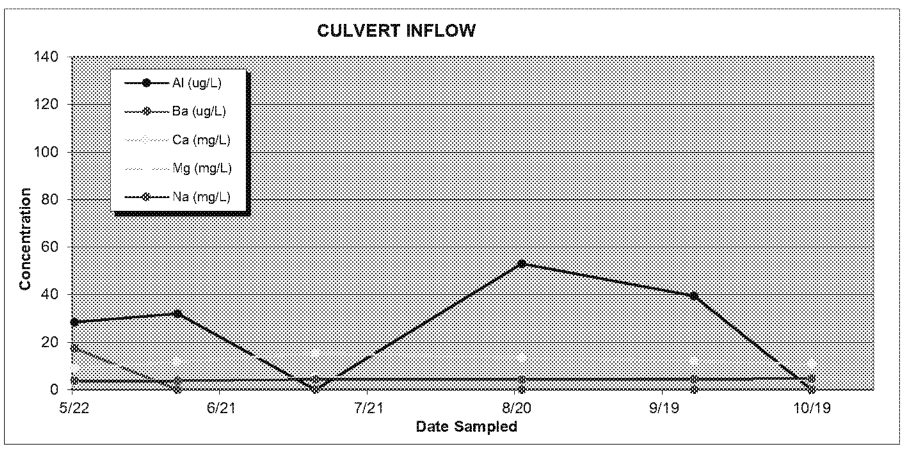
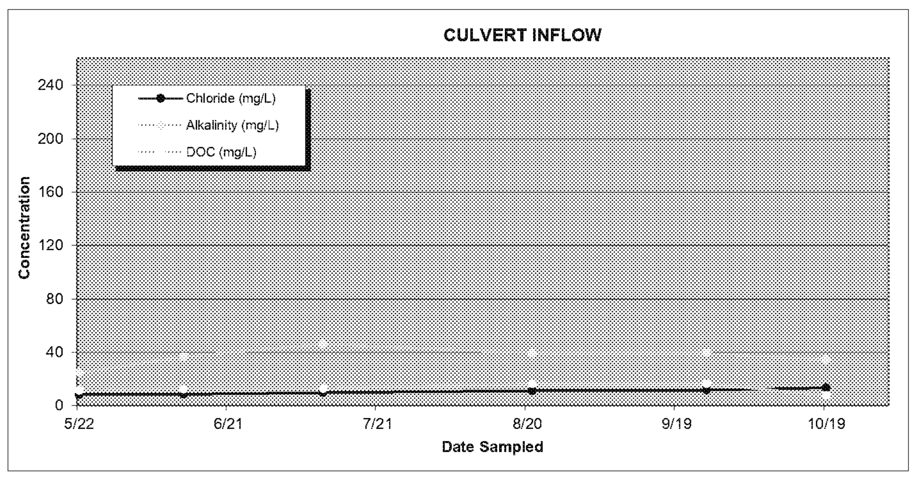
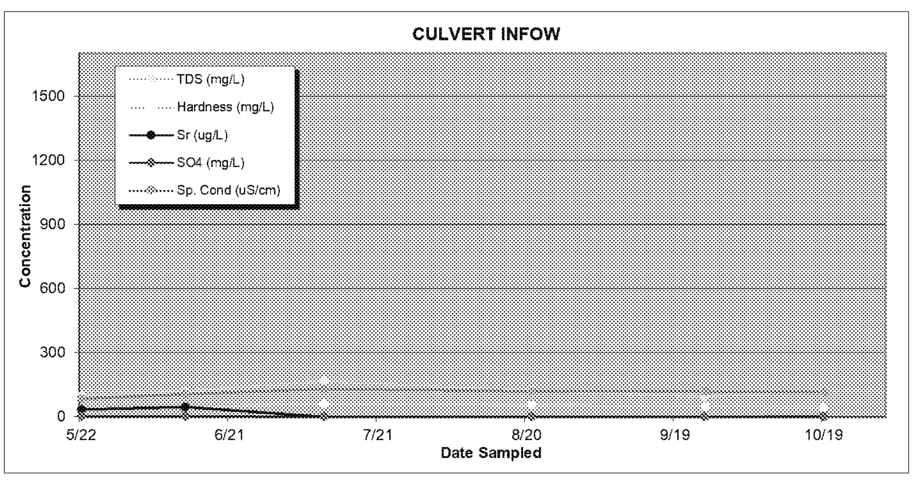
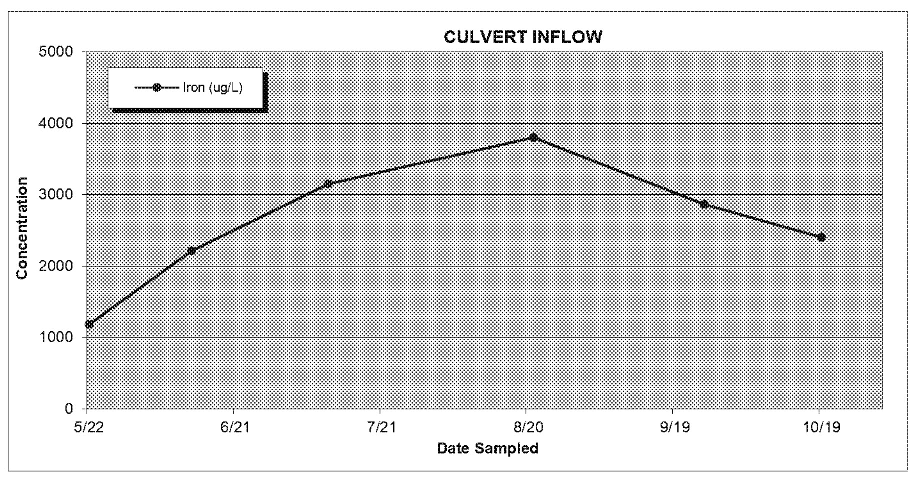
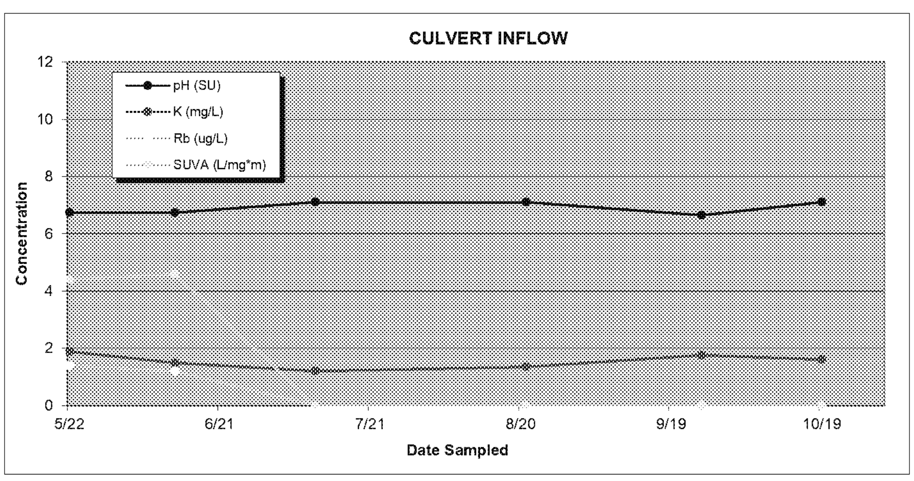
"<" indicates value below reporting limit
For a list of reporting detection limits, see data tables organized by sample date

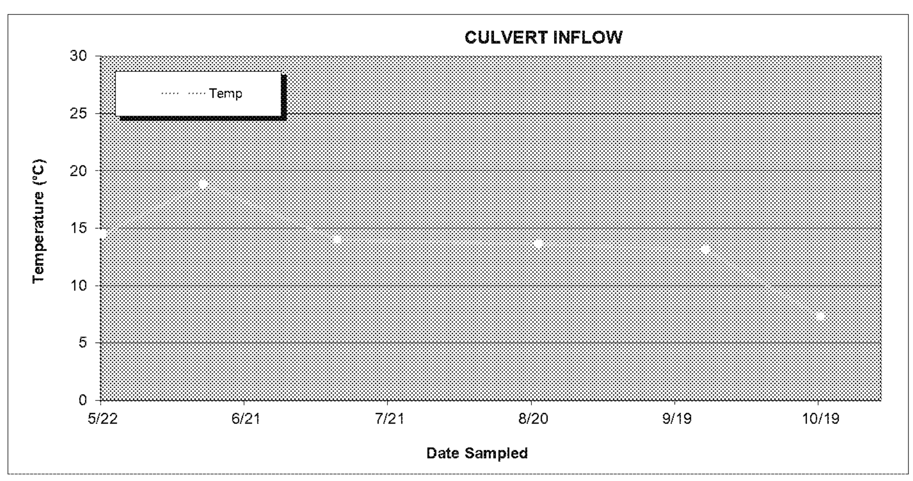








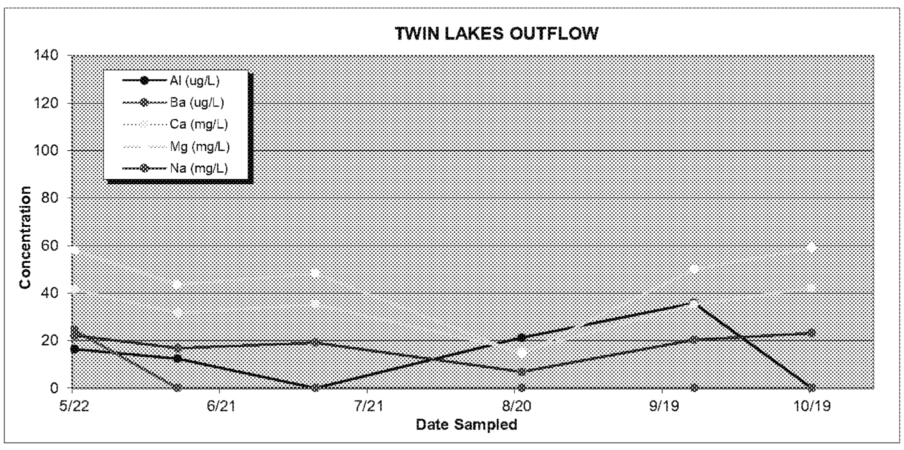


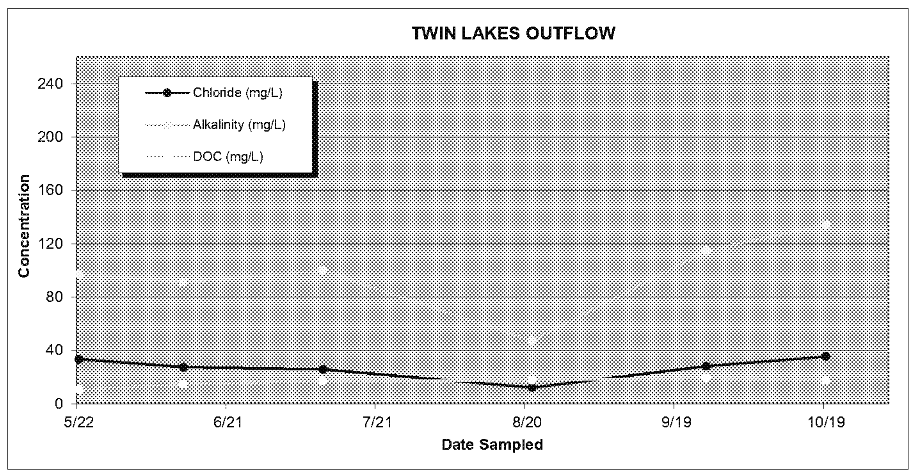


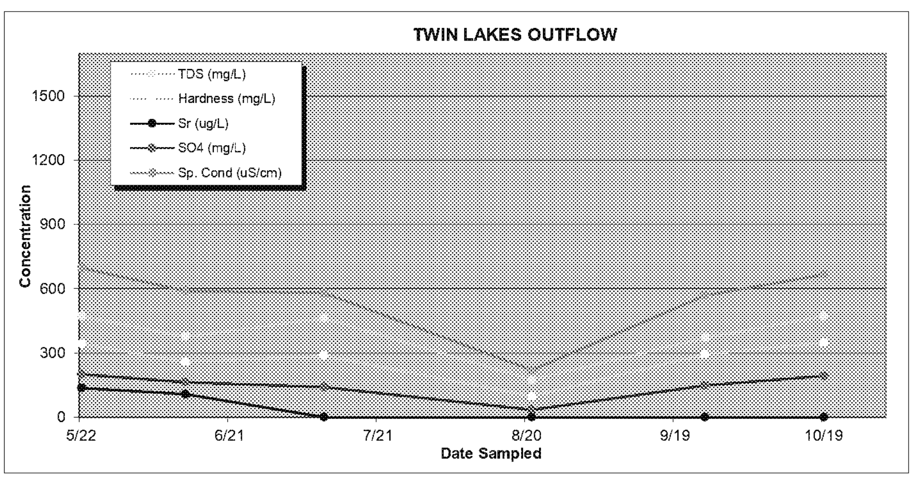
TWIN LAKES OUTFLOW

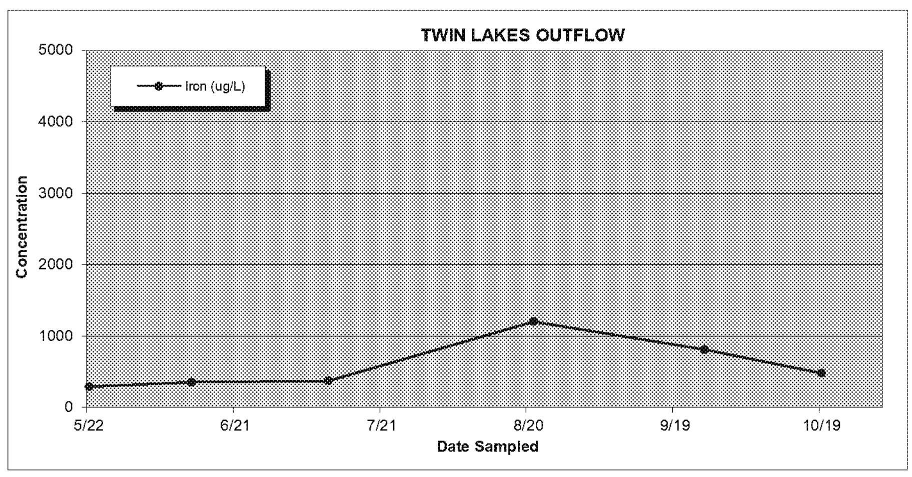
Analytes - Cations	5/22/2015 Twin Lakes Outflow	6/12/2015 Twin Lakes Outflow	7/10/2015 Twin Lakes Outflow	8/21/2015 Twin Lakes Outflow	9/25/2015 Twin Lakes Outflow	10/19/2015 Twin Lakes Outflow	Reporting Units
Aluminum	**16.4**	**12.4**	<50.0	**21.2**	**35.8**	<50.0	µg / L
Arsenic	<0.50	<0.50	NM	NM	NM	NM	µg / L
Barium	**24.4**	NM	NM	NM	NM	NM	µg / L
Calcium	**41.6**	**31.6**	**35.3**	**15.6**	**35.2**	**42.2**	mg / L
Iron	**287**	**350**	**371**	**1200**	**811**	**479**	µg / L
Magnesium	**58**	**43.6**	**48.3**	**14.3**	**50.1**	**59.1**	mg / L
Manganese	**32.6**	**61.8**	**42.5**	**53.9**	**67.5**	**54.4**	µg / L
Phosphorus	<0.10	NM	NM	NM	NM	NM	mg / L
Potassium	**6.03**	**4.81**	**4.6**	**1.79**	**3.8**	**4.3**	mg / L
Rubidium	**2.8**	**2.8**	NM	NM	NM	NM	µg / L
Sodium	**22.2**	**16.8**	**19.1**	**6.9**	**20.3**	**23.2**	mg / L
Strontium	**136**	**107**	NM	NM	NM	NM	µg / L
Analytes - Anions	==========	==========	==========	==========	==========	==========	==========
Chloride	**33.4**	**27.4**	**25.7**	**12.1**	**28.1**	**35.4**	mg / L
Nitrogen, Kjeldahl, Total	**0.57**	**0.58**	**0.72**	**0.61**	**1**	**0.77**	mg / L
Ammonium as Nitrogen	NM	<0.10	<0.10	<0.10	<0.10	<0.10	mg / L
Sulfate	**200**	**163**	**140**	**33.8**	**147**	**192**	mg / L
Analytes - Other	==========	==========	==========	==========	==========	==========	==========
Total Dissolved Solids	**473**	**375**	**462**	**174**	**371**	**473**	mg / L
Total Suspended Solids	NM	**1.6**	**1.6**	<1.2	**2.4**	**4**	mg / L
Alkalinity, Total as CaCO3	**97.3**	**91.1**	**99.9**	**47.4**	**115**	**134**	mg / L
Dissolved Organic Carbon	**10.8**	**14.8**	**17.1**	**17.5**	**19.3**	**17.5**	mg / L
Total Hardness by 2340B	**343**	**259**	**287**	**97.9**	**294**	**349**	mg / L
UV Absorbance @ 254 nm	**0.36**	**0.484**	NM	NM	NM	NM	cm^{-1}
SUVA	**3.5**	**3.3**	NM	NM	NM	NM	L / mg*m
YSI Probe Plus Data	==========	==========	==========	==========	==========	==========	==========
pH	**7.8**	**7.53**	**8.08**	**7**	**7.46**	**8.1**	Units
Temperature	**13.6**	**19.87**	**23.1**	**14.6**	**14.8**	**6.4**	°C
Specific Conductance	**698**	**590**	**581**	**219**	**568**	**666**	uS / cm
Dissolved Oxygen	NM	**7.68**	**9.7**	NM	NM	NM	mg / L

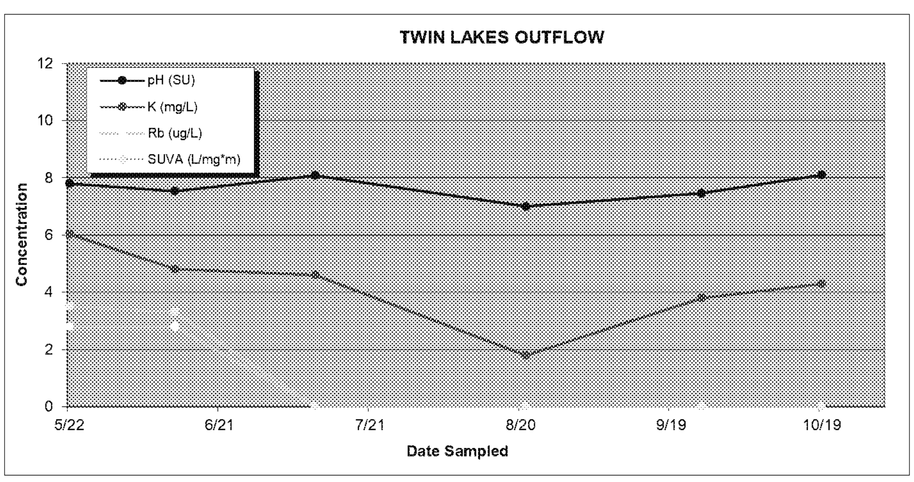
Bold Print indicates the sample is above the detection limit
NM indicates that the analyte was not measured
"<" indicates value below reporting limit
For a list of reporting detection limits, see data tables organized by sample date

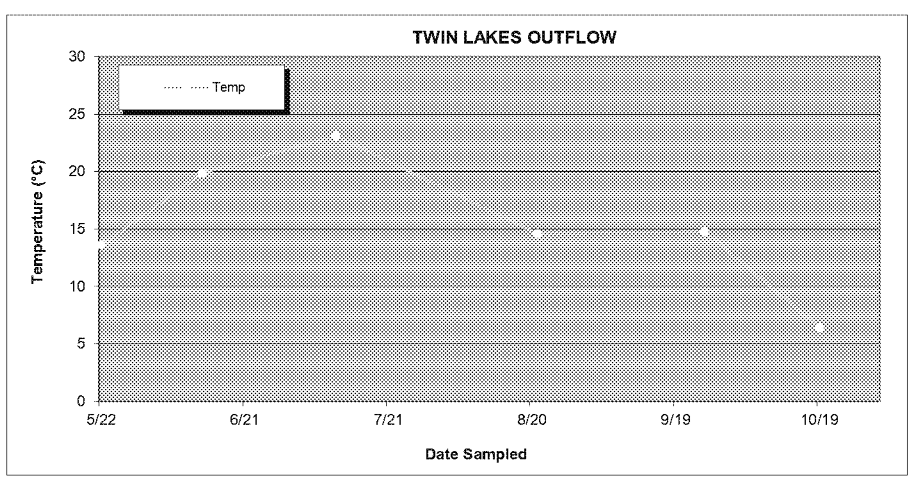












Appendix E

Twin Lakes 2015 Water Inflow / Outflow Flow Measurements

2015 Inflows & Outflows of Twin Lakes

Date Measured	Inflow 1 to LSL Gallon / Min	Tributary to SR Culvert InFlow Gallon / Min	Total Known Flow to Sand River Gallon / Min	701 Sand River Gallon / Min	Known Flows vs. Total %
5/22/2015	6,394	568	6,962	20,964	33%
6/12/2015	3,149	292	3,441	14,721	23%
7/10/2015	1,478	284	1,762	4,858	36%
8/21/2015	3,504	489	3,993	6,036	66%
9/25/2015	1,683	404	2,087	7,294	29%
10/19/2015	1,106	288	1,394	4,711	30%

Note: **Inflows 2 and 3 are not included here due to having no defined channel access.**

APPENDIX F

TWIN LAKES 2015 AQUATIC PLANT SURVEY RESULTS

Twin Lakes Wild Rice Restoration Opportunities Plan
2015 Aquatic Plant Survey
August 18, 2015

Lake: Sandy Lake
Aquatic Plant Interpreter: Katherine Disterhaft
Method: Double-headed Rake

TRANSECT 1

Sampling Station	Water Depth ft	Rake Coverage %	Plant Name (estimated % of total vegetation present on rake)
Station 1	1.5	100	Coontail (100%)
Station 2	1.5	10	Coontail (3%), White water lily (3%), Spatterdock (2%), Bladderwort (2%)
Station 3	2	15	Coontail (12%), Bladderwort (3%)
Station 4	1.75	0	Muck and detritus
Station 5	2	5	Coontail (5%) - muck and detritus
Station 6	2	5	Coontail (3%), Pondweed (Fries' Flatleaf) (2%)

TRANSECT 2

Sampling Station	Water Depth ft	Rake Coverage %	Plant Name (estimated % of total vegetation present on rake)
Station 1	2	5	Cattail (5%) with muck and detritus
Station 2	2.5	20	Chara (18%), Bladderwort (2%)
Station 3	3	30	Chara (24%), Northern watermilfoil (5%), Pondweed (leafy - 1%)
Station 4	2.75	20	Chara (14%), Northern watermilfoil (6%) - muck and detritus
Station 5	3	15	Muskgrass (15%)
Station 6	3.25	35	Sago pondweed (25%), Chara (5%), Clasping pondweed (4%), Northern watermilfoil (1%)

TRANSECT 3

Sampling Station	Water Depth ft	Rake Coverage %	Plant Name (estimated % of total vegetation present on rake)
Station 1	1.5	30	Coontail (29%), Pondweed (1%)
Station 2	2.25	20	Bur-reed (18%), Bladderwort (2%) - caddisfly larvae
Station 3	2.75	0	Detritus
Station 4	2.8	0	Muck
Station 5	2.8	5	Algae (4%), Coontail (1%) - clams
Station 6	3.6	0	Muck

TRANSECT 4

Sampling Station	Water Depth ft	Rake Coverage %	Plant Name (estimated % of total vegetation present on rake)
Station 1	1.5	7	Detritus (5%), Bladderwort (2%)
Station 2	2.5	0	Muck
Station 3	2.5	2	Chara (1%), Clasping pondweed (1%)
Station 4	3.25	15	Filamentous Algae (15%)
Station 5	3.4	0	Muck
Station 6	3.25	2	Muck Filamentous algae (2%) - muck and clams

Twin Lakes Wild Rice Restoration Opportunities Plan

2015 Aquatic Plant Survey

August 18, 2015

Lake: Little Sandy Lake
Aquatic Plant Interpreter: Katherine Disterhaft
Method: Double-headed Rake

TRANSECT 1

Sampling Station	Water Depth ft	Rake Coverage %	Plant Name (estimated % of total vegetation present on rake)
Station 1	2.25	0	(Nothing retrieved)
Station 2	2.8	0	(Nothing retrieved)
Station 3	3	0	Muck
Station 4	3.6	0	Muck

TRANSECT 2

Sampling Station	Water Depth ft	Rake Coverage %	Plant Name (estimated % of total vegetation present on rake)
Station 1	2	15	Detritus (13%), Bladderwort (2%)
Station 2	2.7	15	Bur-reed (8%), Water celery (6%), Northern watermilfoil (1%)
Station 3	3	0	Muck
Station 4	3.5	0	Muck and detritus
Station 5	3.6	0	Muck

TRANSECT 3

Sampling Station	Water Depth ft	Rake Coverage %	Plant Name (estimated % of total vegetation present on rake)
Station 1	1.9	10	Spatterdock (10%)
Station 2	2.6	40	Muskgrass (38%), Northern watermilfoil (2%)
Station 3	3.25	8	Northern watermilfoil (6%), Muskgrass (2%)
Station 4	3.75	0	Muck

TRANSECT 4

Sampling Station	Water Depth ft	Rake Coverage %	Plant Name (estimated % of total vegetation present on rake)
Station 1	1	10	Coontail (10%)
Station 2	2.8	30	Bladderwort (30%)
Station 3	3.4	0	Muck
Station 4	3.5	2	Northern watermilfoil (2%)

Twin Lakes Wild Rice Restoration Opportunities Plan

2015 Aquatic Plant Survey

August 18, 2015

Lake: Sandy Lake
Aquatic Plant Interpreter: Katherine Disterhaft
Method: Above-water Visual Observation

TRANSECT 1

General Note: Floating emergent mass of weeds between Transect 1 and 2

TRANSECT 2

General Note: Observed a large amount of Bur-reed and Water celery in the bay between Transects 2 and 3

TRANSECT 3

Sampling Station	Coverage %	Plant Name (estimated % of total vegetation present from above water visual observation)
Station 1	75	Spatterdock (25%), Northern watermilfoil (25%), Bladderwort (10%), Pondweed (5%), Bur-reed (5%), Coontail (5%)
Station 2	30	Bur-reed (20%), Spatterdock (10%)
Station 3	10	Water celery (7%) Bur-reed (3%)
Station 4	5	Water celery (2%), Bur-reed (2%), Northern watermilfoil (0.5%), White water lily (0.5%)
Station 5	<5	Water lily (2%), Northern watermilfoil (1%)
Station 6	<2	Water lily (1%), Bur-reed (1%)

TRANSECT 4

Sampling Station	Coverage %	Plant Name (estimated % of total vegetation present from above water visual observation)
Station 1	<1	Water lily (<1%)
Station 2	5	Water lily (1%), Spatterdock (1%), Northern watermilfoil (1%), Clasping pondweed (1%), Bur-reed (1%)
Station 3	10	Clasping pondweed (10%)
Station 4	1	Northern watermilfoil (0.5%), Water lily (0.5%)
Station 5	5	Clasping pondweed (2%), Northern watermilfoil (2%), Water lily (1%)
Station 6	<5	Clasping pondweed (<5%)

General Note: Large amount of Water celery present east of transect

Twin Lakes Wild Rice Restoration Opportunities Plan
2015 Aquatic Plant Survey
August 18, 2015

Lake: Little Sandy Lake
Aquatic Plant Interpreter: Katherine Disterhaft
Method: Above-water Visual Observation

TRANSECT 1

Sampling Station	Coverage %	Plant Name (estimated % of total vegetation present from above water visual observation)
Station 1	0	
Station 2	0	
Station 3	0	
Station 4	0	
General Note:	Bullrush patch present west of transect	

TRANSECT 2

Sampling Station	Coverage %	Plant Name (estimated % of total vegetation present from above water visual observation)
Station 1	15	Bur-reed (12%), Water lily (1%), Bladderwort (1%), Northern watermilfoil (1%)
Station 2	15	Bur-reed (10%), Water celery (5%)
Station 3	<5	Bur-reed
Station 4	0	
Station 5	0	

TRANSECT 3

Sampling Station	Coverage %	Plant Name (estimated % of total vegetation present from above water visual observation)
Station 1	<5	Water lily (<5%)
Station 2	10	Muskgrass (5%), Northern watermilfoil (5%)
Station 3	10	Northern watermilfoil (8%), Muskgrass (2%)
Station 4	0	

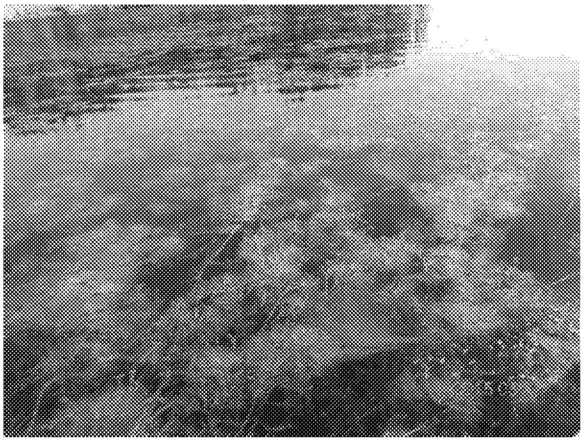
TRANSECT 4

Sampling Station	Coverage %	Plant Name (estimated % of total vegetation present from above water visual observation)
Station 1	10	Coontail (10%)
Station 2	20	Northern watermilfoil (10%), Bladderwort (10%)
Station 3	5	Northern watermilfoil (5%)
Station 4	<5	Northern watermilfoil (<5%)

Appendix G

Twin Lakes 2015 Field Pictures

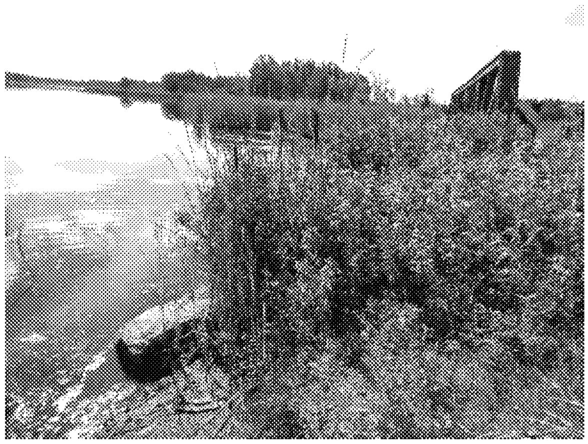
Twin Lakes Pictures
August 5, 2015



Outlet of Sandy Lake

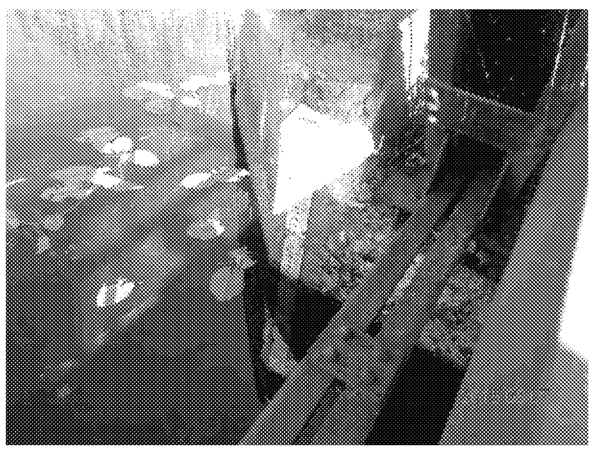
Looking W. on Sandy Lake at Outlet

West Shoreline of SL close to Steel Bridge



Looking S. at E. Side of T. L. Steel Bridge

Looking SW at LSL from Steel Bridge



Staff Gauge located on Steel Bridge

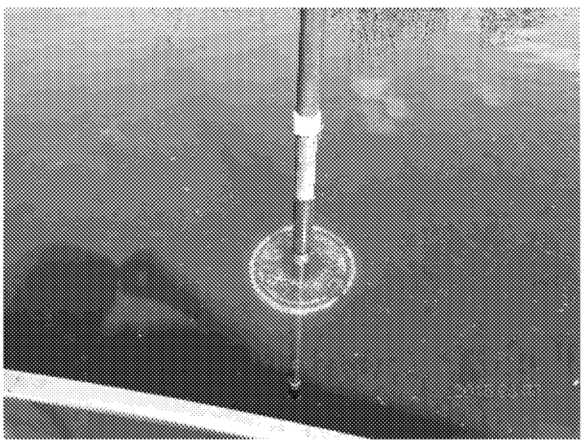
Twin Lakes Pictures
August 5, 2015

Looking W. over LSL from Steel Bridge

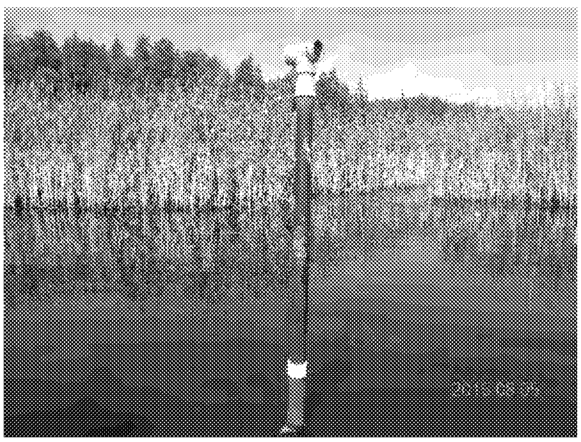
E. Shoreline of LSL by Steel Bridge

Old Roadway Looking South from Steel Bridge

Old Roadway Looking North from Steel Bridge

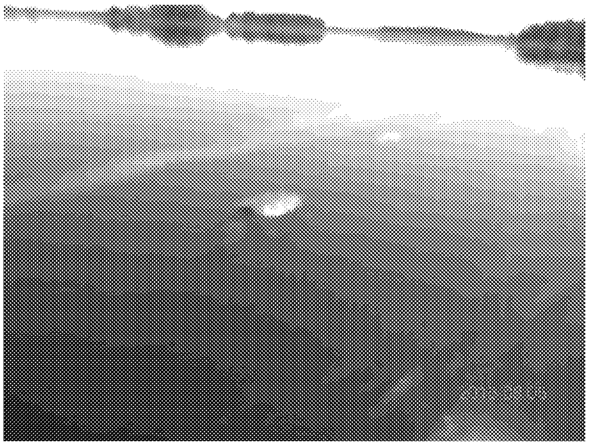


Peeper Site Close to LSL Inflow 1



Looking South Close to LSL Inflow 1

Twin Lakes Pictures
August 5, 2015



Turtles Swimming in Sandy Lake

Peeper Location on East shore of LSL

Twin Lakes Steel Bridge Looking West

APPENDIX H

BEAVER MANAGEMENT

Agreement No.: 15 7227 5084 RA
WBS: AP.RA.RX27.72.0071

COOPERATIVE SERVICE AGREEMENT
between
United States Steel Corporation
and
UNITED STATES DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE (APHIS)
WILDLIFE SERVICES (WS)

ARTICLE 1

The purpose of this Cooperative Service Agreement is to provide for services performed by USDA / APHIS / Wildlife Services (hereinafter referred to as "APHIS-WS") to manage beaver damage to facilities owned or controlled by the United States Steel Corporation (USS).

ARTICLE 2

APHIS-WS has statutory authority under the Act of March 2, 1931 (46 Stat. 1468; 7 U.S.C.426-426b) as amended, and the Act of December 22, 1987 (101Stat. 1329-331, 7 U.S.C. 426c), to cooperate with States, local jurisdictions, individuals, public and private agencies, organizations, and institutions while conducting a program of wildlife services involving mammal and bird species that are reservoirs for zoonotic diseases, or animal species that are injurious and/or a nuisance to, among other things, agriculture, horticulture, forestry, animal husbandry, wildlife, and human health and safety.

ARTICLE 3

APHIS-WS and USS mutually agree:

1. The parties' authorized representatives who shall be responsible for carrying out the provisions of this Agreement shall be:

USS:	Lawrence Sutherland United States Steel Corporation P.O. Box 417 Mountain Iron, MN 55768
APHIS-WS:	Gary Nohrenberg, State Director USDA, APHIS, WS 644 Bayfield St., Suite 215 St. Paul, MN 55107

2. To meet as determined necessary by either party to discuss mutual program interests, accomplishments, needs, technology, and procedures to maintain or amend the Work Plan (Attachment A). Personnel authorized to attend meetings under this Agreement shall be Lawrence Sutherland or his/her designee, the State Director or his/her designee, and/or those additional persons authorized and approved by Lawrence Sutherland and the State Director.

3. APHIS-WS shall perform services more fully set forth in the Work Plan, which is attached hereto and made a part hereof. The parties may mutually agree in writing, at any time during the term of this Agreement, to amend, modify, add or delete services from the Work Plan.

ARTICLE 4

Cooperator agrees:

1. To authorize APHIS-WS to conduct direct control activities to reduce damage to roads, bridges, culverts and right-of-ways associated with beaver activity at specified damage sites in USS. These activities are defined in the Work Plan. APHIS-WS will be considered an invitee on the lands controlled by USS. USS will be required to exercise reasonable care to warn APHIS-WS as to dangerous conditions or activities in the project areas.

2. To reimburse APHIS-WS for costs of services provided under this Agreement up to but not exceeding the amount specified in the Financial Plan (Attachment B). USS will begin processing for payment invoices submitted by APHIS-WS within 30 days of receipt. The Cooperator ensures and certifies that it is not currently debarred or suspended and is free of delinquent Federal debt.

3. To designate to APHIS-WS the USS authorized individual whose responsibility shall be the coordination and administration of activities conducted pursuant to this Agreement.

4. To notify APHIS-WS verbally or in writing as far in advance as practical of the date and time of any proposed meeting related to the program.

5. APHIS-WS shall be responsible for administration and supervision of the program.

6. There will be no equipment with a procurement price of $5,000 or more per unit purchased directly with funds from the cooperator for use solely on this project. All other equipment purchased for the program is and will remain the property of APHIS-WS.

7. To coordinate with APHIS-WS before responding to all media requests.

ARTICLE 5

APHIS-WS Agrees:

1. To conduct activities as described in the Work and Financial Plans.

2. Designate to USS the authorized APHIS-WS individual who shall be responsible for the joint administration of the activities conducted pursuant to this Agreement.

3. To bill USS and invoice quarterly for actual costs incurred by APHIS-WS during the performance of services agreed upon and specified in the Work Plan. Any proceeds from beaver and castor salvage will go toward beaver management activities. APHIS-WS shall keep records and receipts of all reimbursable expenditures hereunder for a period of not less than one year from the date of completion of the services provided under this Agreement and USS shall have the right to inspect and audit such records.

4. To coordinate with USS before responding to all media requests.

5. To provide an annual summary of work completed for the period covered by the agreement period, delineated by damage site, including number of beaver trapped and dams removed.

6. To obtain the appropriate permits for beaver removal activities.

7. To take reasonable precautions to prevent spread of exotic invasive species by cleaning equipment and avoiding transfer of water, soil, and plant material from one site to another.

ARTICLE 6

This Agreement is contingent upon the passage by Congress of an appropriation from which expenditures may be legally met and shall not obligate APHIS-WS upon failure of Congress to so appropriate. This Agreement may also be reduced or terminated if Congress only provides APHIS-WS funds for a finite period under a Continuing Resolution.

ARTICLE 7

APHIS-WS assumes no liability for any actions or activities conducted under this Cooperative Service Agreement except to the extent that recourse or remedies are provided by Congress under the Federal Tort Claims Act (28 U.S.C. 1346(b), 2401(b), and 2671-2680).

ARTICLE 8

Pursuant to Section 22, Title 41, United States Code, no member of or delegate to Congress shall be admitted to any share or part of this Agreement or to any benefit to arise therefrom.

ARTICLE 9

Nothing in this Agreement shall prevent APHIS- WS from entering into separate agreements with any other organization or individual for the purpose of providing wildlife damage management services exclusive of those provided for under this agreement.

ARTICLE 10

Cooperator certifies that APHIS-WS has advised USS that there may be private sector service providers available to provide wildlife management services that USS is seeking from APHIS-WS.

ARTICLE 11

The performance of wildlife damage management actions by APHIS-WS under this agreement is contingent upon a determination by APHIS-WS that such actions are in compliance with the National Environmental Policy Act, Endangered Species Act, and any other applicable federal statutes. APHIS-WS will not make a final decision to conduct requested wildlife damage management actions until it has made the determination of such compliance.

ARTICLE 12

This Cooperative Service Agreement may be amended at any time by mutual agreement of the parties in writing. Also, this Agreement may be terminated at any time by mutual agreement of the parties in writing, or by one party provided that party notifies the other in writing at least 120 days prior to effecting such action. Further, in the event the Cooperator does not provide necessary funds, APHIS-WS is relieved of the obligation to provide services under this agreement.

In accordance with the Debt Collection Improvement Act of 1996, the Department of Treasury requires a **Taxpayer Identification Number** for individuals or businesses conducting business with the agency.

USS Federal Taxpayer Identification Number (TIN): ____________________

UNITED STATES STEEL CORPORATION:

BY: ______________________________ ____________________

Lawrence Sutherland — Date
United States Steel Corporation
P.O. Box 417
Mountain Iron, MN 55768

UNITED STATES DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
WILDLIFE SERVICES

BY: ______________________________ ____________________

Charles S. Brown — Date
Director, Eastern Region
USDA, APHIS, WS
920 Main Campus Drive
Suite 200
Raleigh, NC 27606

ATTACHMENT A
WORK PLAN

Introduction

The U.S. Department of Agriculture (USDA) is authorized to protect American agriculture and other resources from damage associated with wildlife. The primary authority for Wildlife Services (WS) is the Act of March 2, 1931 (46 Stat. 1468; 7 U.S.C.426-426b) as amended, and the Act of December 22, 1987 (101Stat. 1329-331, 7 U.S.C. 426c). Wildlife Services activities are conducted in cooperation with other Federal, State and local agencies; private organizations and individuals.

The WS program uses an Integrated Wildlife Damage Management (IWDM) approach (sometimes referred to as IPM or "Integrated Pest Management") in which a series of methods may be used or recommended to reduce wildlife damage. IWDM is described in Chapter 1, 1-7 of the Animal Damage Control Program Final Environmental Impact Statement (USDA, 1994). These methods include the alteration of cultural practices as well as habitat and behavioral modification to prevent damage. However, controlling wildlife damage may require that the offending animal(s) are killed or that the populations of the offending species be reduced.

Purpose

United States Steel Corporation has requested APHIS-WS assistance to resolve damage to timber, wild rice, roads, bridges, culverts and right-of-ways caused by beavers and their dams at various damage sites.

Planned USDA, APHIS, Wildlife Services Activities

APHIS-WS will attempt to reduce beaver damage on streams and waterways related to United States Steel Corporation jurisdiction, by removing resident beaver and their associated dams. Beaver will be removed via trapping or shooting and dams will be removed via binary explosives or with hand rakes. Beaver and dam removal will only be conducted under the direction of the Cooperator. APHIS-WS will return to previously worked damage sites if any fresh beaver activity is documented within 30 days of completion and remove any remaining beaver and dams at no cost to the Cooperator.

The following WS personnel are authorized to work under this agreement:

-John Hart	-Jim Carlson
-Duane Sahr	-Tylor Rasmussen
-Jeff Grabarkewitz	-Dave Kuehn
-Gary Barrett	-Dave Hughley

Effective Dates

The cooperative agreement shall become effective on April 1, 2015, and shall expire on December 31, 2015.

ATTACHMENT B TO THE USDA APHIS WILDLIFE MANAGEMENT AGREEMENT INTENTIONALLY LEFT BLANK

Appendix I

Twin Lakes Wild Rice Re-seeding Effort

APPLICATION TO COLLECT AND/OR TRANSPLANT AQUATIC VEGETATION

MNDNR

Please Print or Type

Applicant's Name (First, M.I., Last) Daniel C. Ryan - Superior National Forest	Home Residence Telephone Number ( )
Home Address (No. & Street, RFD, Box No., City, State, Zip Code) 318 Forestry Rd. Aurora, MN 55705	Lake Residence Telephone Number (if different) ( )
Lake Address (No. & Street, RFD, Box No., City, State, Zip Code)	Work Telephone Number (daytime) (218) 229-8809

Lake Name Where Plants are to be Transplanted

Lake Name or Bay	County	
Twin Lakes (Sandy + Little Sandy)	St. Louis	

Types and Sources of Plants to be Transplanted (attached additional pages if needed)

Common Name of Plant	Scientific Name (required)	No. Plants & Type of Plant material	Source of Plants Lake Name & County and/or Company Name & Address
Wild Rice	Zizania palustris	40 pounds seed	Sand River upstream of Hwy 169. Collected on 9/14/15.

REASON FOR PROJECT *(explain why this project is desired)*

Attached summary and figure showing proposed reseeding plots.

Sketch proposed collection and transplant area on back of this application or on a separate sheets of paper. Indicate compass direction "North"; location on lake (shore, point, bay, etc.); dimensions of proposed collection and transplant areas with names and total frontages of each property owner. Include fire number, noteworthy landmark, and enough detail so that the property can be located for possible inspection.

MAKE SURE THAT YOU HAVE INCLUDED THE FOLLOWING INFORMATION: Sketch/Maps ☒ Plant List ☒ Source of Plants ☒ Signature ☒

I hereby make application for a permit to collect and transplant aquatic vegetation as described below. I understand that the collection and transplanting of aquatic vegetation is subject to rules and regulations of the Commissioner of Natural Resources. I understand that an Aquatic Plant Management Specialist may wish to inspect the above areas before, during, and/or after work is completed and that by making this application I give permission to the specialist to enter my property to make such inspection at reasonable times. I understand that an annual report may be required on all work done and results achieved.

Applicant's Signature	Date
[signature]	9/30/15

APPENDIX J

TWIN LAKES 2016 ACTIVITIES PLAN

U. S. Steel Minntac

Twin Lakes Wild Rice Restoration Opportunities Plan

Proposed Implementation Plan - 2016 Plan Activities

April-16	May-16	June-16	July-16	August-16	September-16	October-16	November-16	December-16
1 Install PT at Bridge	1 Monthly Water Quantity / Quality Monitoring	1 Monthly Water Quantity / Quality Monitoring	1 Monthly Water Quantity / Quality Monitoring	1 Monthly Water Quantity / Quality Monitoring	1 Monthly Water Quantity / Quality Monitoring	1 Monthly Water Quantity / Quality Monitoring	1 Collect water depth data and remove PT for Winter storage	1 Prepare and Submit Annual Report 12/31/16
2 Begin Trapping Beaver. Evaluate Dam removal and remove as needed	2 Collect water depth data	2 Collect water depth data	2 Collect water depth data	2 Collect water depth data	2 Collect water depth data	2 Collect water depth data		
	3 Observe and document WR growth	3 Observe and document WR growth	3 Observe and document WR growth	3 Observe and document WR growth	3 Observe and document WR growth	3 Recover Peepers		
3 Deploy Peepers	4 Recover Peepers and redeploy	4 Recover Peepers and redeploy	4 Recover Peepers and redeploy	4 Recover Peepers and redeploy	4 Recover Peepers and redeploy			
			5 Assess both lakes for areas suitable for WR seeding & schedule date for re-seeding, if appropriate.	5 Complete Aquatic Plant Survey				

Environmental Science & Engineering